SIX SIGMA IMPLEMENTATION IN MIDDLE EAST ORGANISATIONS

An Empirical Study

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ABSTRACT

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SIX SIGMA IMPLEMENTATION IN MIDDLE EAST ORGANISATIONS

An Empirical Study

Keywords: Six Sigma, Implementation, Middle East, Empirical study, Reasons/Benefits, Challenges, Critical success factors (CSFs), Satisfaction, Saudi Arabia, Egypt, United Arab Emirates (UAE).

In the last decade, the rapid economic development in the Middle East has encouraged organisations to implement modern quality management and strategic initiatives such as Six Sigma to ensure continuous improvement and achieved excellence. Six Sigma is a comprehensive business strategic quality programme and a systematic process improvement methodology for achieving, sustaining and maximising business success. The proper implementation of Six Sigma leads to breakthrough in profitability through ensuring quantum gains in product/service quality, customer satisfaction and productivity.

This research presents an empirical exploratory and comparative study that aims and attempts to bridge the gap in the existing literature of Six Sigma by investigating the current implementation status of Six Sigma in organisations of three Middle East countries (namely, Saudi Arabia, Egypt and United Arab Emirates (UAE)). The reasons/benefits that encourage Middle East organisations to implement Six Sigma projects, the challenges commonly faced during implementation, the critical success factors (CSFs) for effective implementation and the organisations' satisfaction with the implementation are investigated.

The key issues of Six Sigma implementation and their criticality relating to the experience of the implementing process of Six Sigma projects are explored through an extensive review of the relevant literature. The data were collected from a combination of quantitative (232 questionnaires) and qualitative (74 semi-structured interviews) methodologies. The research covered 44 organisations from manufacturing and services sectors and large, small, and medium enterprises (SME) sizes, which have implemented or were implementing Six Sigma projects in the selected countries at the time of study.

The study findings identified 15 significant reasons/benefits which encourages Middle East organisations to implement Six Sigma projects, 13 major challenges commonly faced during implementation, 19 CSFs for effective implementation and level of the organisations' satisfaction with the implementation. Based on the research findings, a generic model for successful and effective implementation of Six Sigma in Middle East organisations is developed and proposed.

The research concludes that Six Sigma implementation in Middle East organisations still in early stage, most organisations have outstanding opportunities to implement the Six Sigma project successfully and effectively with tangible and intangible benefits. In addition, all the responding organisations, which are actively implementing Six Sigma programme, regardless of their countries, sectors and sizes are highly satisfied with the implementation results. However, the research output highlights that an improvement culture must be developed and promoted throughout the organisation to ensure long-term benefit and sustainable success. Furthermore, the research makes recommendations on development of an implementation strategy in Middle East organisations. Finally, a number of suggestions are made for future research.

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I dedicate this thesis to

The memory of my father,
(may Allah shed his mercy on him)
Who taught me that commitment, dedication and hard work are the basis and essentials for a successful life.

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Who has always inspired me with her prayer, love, wisdom and kept praying that Allah would help make this a success.

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LIST OF ABBREVIATIONS (Acronyms)

The following abbreviations are used in this thesis:

6σ	: Six Sigma
α	: Coefficient of Cronbach Alpha
ASQ	: American Society for Quality
BB	: Black Belt
BP	: Best Practice
BPR	: Business Process Re-engineering
CEO	: Chief Executive Officer
CI	: Continuous Improvement
COPQ	: Cost of Poor Quality
COQ	: Cost of Quality
CS	: Customer Satisfaction
CSFs	: Critical Success Factors
CTC	: Critical-to-Customer
CTQ	: Critical-to-Quality
DFSS	: Design for Six Sigma
DPMO	: Defects per Million Opportunities
DMADV	: Define-Measure-Analyse-Design-Verify
DMAIC	: Define-Measure-Analyse-Improve-Control
DPO	: Defects per Opportunity
DPU	: Defects per Unit
EFQM	: European Foundation of Quality Management
GB	: Green Belt
GE	: General Electric
HR	: Human Resources
ISO	: International Organisation for Standardisation
IT	: Information Technology
KSA	: Kingdom of Saudi Arabia
MBB	: Master Black Belt
MBNQA	: Malcolm Baldrige National Quality Award
MEQA	: Middle East Quality Association
OI	: Organisational Infrastructure
PDCA	: 'Plan', 'Do', 'Check', 'Act'
PI	: Process Improvement
PIs	: Performance Indicators
PM	: Performance Management
PMP	: Performance Management Process
POT	: 'People', 'Organisation', 'Technology'
QC	: Quality Control
QMS	: Quality Management Systems
SD	: Standard Deviation
SME	: Small Medium Enterprise
SPC	: Statistical Process Control
SPSS	: Statistical Package for Social Science
SQC	: Statistical Quality Control
TQM	: Total Quality Management
UAE	: United Arab Emirates
UK	: United Kingdom
USA	: United States of America
VOC	: Voice of Customer
YB	: Yellow Belt

LIST OF PUBLICATIONS
in Refereed Journals and Conference Proceedings

The following papers have been/will be published related to the results of the work undertaken by the author during the course of this PhD research study:

1. Ashri, F. and Hafeez, K. (2008). A Study of Critical Success Factors for Six Sigma Implementation in Saudi Organisations, Saudi Innovation International Conference (SIIC), 9&10 June, Leeds University, Leeds, UK. ISBN: 978-0-9559241-0-1.

2. Ashri, F. and Hafeez, K. (2009). Six Sigma Implementation in Saudi Organisations, 3rd Saudi International Conference (SIC), 5&6 June, University of Surrey, Guildford, UK. ISBN: 1-84469-020-2 and 978-84469-020-6.

3. Ashri, F., Abdi, R. and Hafeez, K. (2010a). Challenges of Six Sigma Implementation in Saudi Organisations, 4th Saudi International Conference (SIC), 30&31 July, The University of Manchester, Manchester, UK.

4. Ashri, F., Abdi, R. and Hafeez, K. (2010b). Reasons for/ Benefits of Six Sigma Implementation in Saudi Organisations, *Poster,* 4th Saudi International Conference (SIC), 30&31 July, The University of Manchester, Manchester, UK. *Gold Poster Award.*

5. Ashri, F., Hafeez, K. and Abdi, R. (2010). Six Sigma Implementation in Middle East Organisations - An Empirical Study, 4th International Conference on Six Sigma, 13&14 December, Scotland, UK.

6. Ashri, F. and Hafeez, K. (2010). Challenges of Six Sigma Implementation in Middle East Organisations. 5th Quality Conference in the Middle East, 31 January - 3 February, 2011, Dubai, UAE.

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8. Reasons for/ Benefits of Six Sigma Implementation in Middle East Organisations. *Work in progress for journal submission.*

9. Challenges of Six Sigma Implementation in Middle East Organisations. *Work in progress for journal submission.*

10. Critical Success Factors for Six Sigma Implementation in Middle East Organisations. *Work in progress for journal submission.*

GLOSSARY OF SIX SIGMA TERMS

A number of key terms are useful in the present study:

Best Practice (BP): A way or method of accomplishing a business function or process that is considered to be superior to all other known methods. A lesson learned from one area of a business that can be passed on to another area of the business or between businesses (ASQ, 2003; Berger, 2003).

Black Belt (BB): Specific Six Sigma term to describe team leader and one who has achieved an accredited BB qualification through an appropriate training course. Six Sigma team leader responsible for implementing Six Sigma process improvement projects (DMAIC or DFSS) within the business that influence customer satisfaction and/or productivity growth. Purpose is to increase customer satisfaction levels and business productivity. Knowledgeable and skilled in use of Six Sigma methodology and tools, is a full-time Six Sigma team leader solving problems under the direction of a Six Sigma Champion. Trained in methodology to solve product and process defects project by project with financially beneficial results (ASQ, 2003). Does Six Sigma analyses and works with others (often teams) to put improvements in place. A highly skilled Six Sigma expert who has completed four weeks of classroom learning of the Six Sigma DMAIC methodology and, over four to six months, demonstrated mastery of the tools through completion of a major process improvement project, analytical problem solving and change management methods. Knows how to define and successfully launch a project, how to transition it from phase to phase and, finally, how to complete a project and evaluate its success. Adept at applying analytical tools to problem solving, and in utilising Six Sigma methodologies in an overall approach to process improvement. Often provides guidance and training to GBs and in turn, receives guidance and training from MBBs. BB training process is a robust 24-day programme spread over five months, during which, BB trainees take concepts learned during courses and apply them to real organisation projects. Full-time team leader responsible for implementing process improvement projects within the business to drive up customer satisfaction levels and business productivity. Massive investment in BB training is a key feature in all Six Sigma programmes (Pande *et al.* 2000; ASQ, 2003).

Champion: (called project sponsor in some organisations) Member of senior management and Six Sigma leader responsible for the guidance and direction of BBs. He/she recognises, defines, assigns and supports successful completion of Six Sigma projects; accountable for results of projects and business roadmap to achieve Six Sigma results within his/her span of control. Champions promote Six Sigma methodology throughout the organisation, especially in specific functional groups. They understand the discipline and tools of Six Sigma, select projects, establish measurable objectives, serve as coach and mentor, remove barriers and dedicate resources in support of BBs. They monitor projects and measure savings realised. Responsible for identifying projects, allocating resources and ensuring proper training for leaders involved in Six Sigma implementations (ASQ, 2003). Champion training focuses on teaching deployment leaders how to properly identify Six Sigma projects, foresee potential project challenges and set realistic expectations that ultimately drive financial results. A business leader or senior manager who ensures resources are available for training and projects and is involved in project tollgate reviews; also, executive who supports and addresses Six Sigma organisational issues (ASQ, 2003). Provides guidance to project team and finds and negotiates resources and budget for the project. A fully trained business leader who promotes and leads deployment of Six Sigma in a significant area of the business.

Cost of Poor Quality (COPQ): Costs associated with any activity not done right the first time. Financial qualification of any waste not integral to the product (ASQ, 2003).

Critical to Quality (CTQ): Key measurable characteristics of product or process or system whose performance standards or specification limits must be met in order to satisfy the customer. They align improvement or design efforts with customer requirements. Element within a process with major influence on process quality and typically quality of a critical process, or it would be unlikely to be receiving Six Sigma attention. CTQ elements of a process significantly affect process output. Identifying these elements is vital to figuring out how to make improvements that can dramatically reduce costs and enhance quality (ASQ, 2003).

Culture: Beliefs, expectations and ways of operating, and behaviours that characterise the interactions of people in any organisation. It is about how things are done around an organisation. Culture evolves over a long period of time and often reflects beliefs and behaviours of top management. Because Six Sigma affects the way things are done, its successful implementation will require a change in culture that may be profound (Berger, 2003).

Customer: Anyone who uses or consumes output of a process, whether internal or external to the providing organisation or provider. Someone for who work or a service is performed. The end user of a product is a customer of the employees within an organisation that manufactures the product. There are also internal customers in an organisation. When an employee does work or performs a service for someone else in the organisation, the person receiving this work is a customer of this employee. He/she is any recipient of a product or service; also anyone who is affected by the product or service. A customer can be external or internal to the organisation. Paying customers are external (Berger, 2003).

Defect: Measurable characteristic of process or output not within the acceptable customer limits, i.e., not conforming to specifications. Failure to meet particular qualitative requirement imposed on a unit. Also, anything that not meeting the customer's critical criteria and defects are sources of customer irritation. Defect is costly to both customers and manufacturers or service providers. Eliminating defects provides cost benefits. Defect is also an output of a process that fails to meet a defined specification or requirement. It is failing to deliver what the customer wants and is a vital and generic Six Sigma term for any failure in meeting customer expectation (internal and external customers): any failure within the delivery process (ASQ, 2003).

Defects per Million Opportunities (DPMO): Average number of defects per unit observed during an average production run divided by the number of opportunities to make a defect on the product under study during that run normalised to one million. When using the non-conformance rate calculation of DPMO one first needs to describe the opportunities for defects in the process (e.g. the number of components and solder joints when manufacturing printed circuit boards) (ASQ, 2003).

Design for Six Sigma (DFSS): Structured approach for designing product or service processes. DFSS is based on variations of the steps Define, Measure, Analyse, Design and Verify. DFSS is a systematic methodology using tools, training and measurements to enable design of products and processes that meet customer expectations and can be produced at Six Sigma quality levels. DFSS is the use of Six Sigma thinking, tools and methods applied to the design of products and services to improve initial release performance, ongoing reliability and life-cycle cost. DFSS is commonly used in Six Sigma activities and communications and describes the method of using tools, training, measurements, and verification so that products and processes are designed at the outset to meet Six Sigma requirements. It is concerned with and emphasises the importance of using Six Sigma principles in product/process design, not just for remedial improvements - rather advocating that prevention is better than cure (ASQ, 2003).

DMAIC: DMAIC (pronounced Duh-May-Ick) is the process improvement methodology of Six Sigma and refers to a data-driven quality strategy for improving processes and is an integral part of the organisation's Six Sigma quality initiative. DMAIC is a process for continued improvement, it is systematic, scientific and fact-based. It is a systematic closed-loop process for continued improvement that eliminates unproductive steps, focuses on new measurements and applies technology for improvement. DMAIC stands for five interconnected phases: Define, Measure, Analyse, Improve and Control, used to solve process and business problems through data and analytical methods. It is a Six Sigma roadmap. The DMAIC approach is designed to deal with processes generally well understood in organisations but which have not been rigorously analysed using numerical data, particularly financial data, to identify potential additional productivity improvements (ASQ, 2003).

Employees: Persons not authorised to command or influence others, nor involved in decision making for the overall management process. Employees report to the manager and are contractually required to obey the manager (Berger, 2003).

Green Belt (GB): Six Sigma team member who has received GB training and who works on Six Sigma projects under the guidance of a BB team leader. He/she has been trained in the improvement methodology of Six Sigma and will lead a process improvement or quality improvement team as part of his/her full-time job. He/she receives approximately two weeks of training in Six Sigma DMAIC methodology, analytical problem solving and change management methods in two intensive 5-day training sessions. Between sessions, students return to their organisations to apply the tools and processes of Six Sigma to their own projects. GBs apply Six Sigma techniques to their local area, performing smaller-scoped projects and providing support to BB projects. They have a demonstrated level of competence with Six Sigma philosophy, tools and techniques and are usually found in two roles: first, in the management ranks, where they learn Six Sigma and, second, in teams where they acquire competence to participate in Six Sigma projects (ASQ, 2003). GB has in-depth knowledge of the Six Sigma methodologies and is an integral member of the team. He/she plays an important role in executing Six Sigma projects on an organisational level and has a strong familiarity with existing organisation products and processes. He/she is adept at defining, staffing, presenting and gathering and using data to analyse Six Sigma projects. A GB is a person with working knowledge of Six Sigma methodology and tools, who has completed training and a project to drive high-impact business results (ASQ, 2003). GBs also work on improvement projects on a part-time basis. They have quantitative skills as well as leadership ability; they are fully-trained quality leaders responsible for Six Sigma strategy, training, mentoring, deployment and results and are business team leaders responsible for managing projects and implementing improvement in his/her organisation (ASQ, 2003).

Manager: A person authorised by formal or legitimate right to make decisions about the overall management process towards the accomplishment of organisational goals (Bennis, 1997; Berger, 2003).

Master Black Belt (MBB): Six Sigma quality expert who acts as a leader to drive change initiatives within an organisation. He/she has deep knowledge of the principles and processes of Six Sigma and design for Six Sigma. The MBB is qualified to teach other Six Sigma facilitators, Six Sigma BBs, GBs, YBs and Champions, the methodologies, tools and applications in all functions and levels of the organisation, and acts as a resource for applying statistical process control (SPC) to projects within processes (ASQ, 2003). MBB programme combines in-depth coursework with rigorous testing and a required demonstration of thought leadership through publication and teaching. He/she receives additional training beyond BB. A technical, go-to expert for technical and project issues in Six Sigma, a highly qualified Six Sigma practitioner, typically concerned with overseeing Six Sigma activities from an organisational perspective. A teacher and mentor of BBs, first and foremost a teacher providing support, reviewing projects and undertaking larger scale projects. Full-time position for Six Sigma quality expert responsible for strategic implementations within an organisation. Main responsibilities include training and mentoring of BBs and GBs, helping to prioritise, select and charter high-impact projects, maintaining integrity of Six Sigma measurements, improvements and tollgates, and developing, maintaining and revising Six Sigma training materials. After year-long project-based certification programme, MBBs are fully-trained quality leaders responsible for Six Sigma strategy, training, mentoring, deployment and results, as Six Sigma expert most highly skilled in methodologies of variation reduction. MBBs have progressed from BBs because of extensive experience with improvement projects, teaching and mentoring and good knowledge of more advanced improvement tools (ASQ, 2003).

Process: Method to make or do something that involves a number of steps. Process is a set of activities, materials and/or information flow that transforms a set of inputs into outputs for producing a product, providing a service or performing a task. And it is any repetitive action, whether in a transactional, manufacturing or services environment. Six Sigma methodology collects data on variations in outputs associated with each process, so that it can be improved and variations reduced (ASQ, 2003).

Sigma: Greek letter (σ) used in statistics to represent standard deviation; an indicator of the degree of variation in a set of measurements or a process. It refers to the standard deviation of a population. Sigma, or standard deviation, is used as a scaling factor to convert upper and lower specification limits to Z. Therefore, a process with three standard deviations between its mean and a spec limit would have a Z value of 3 and would commonly be referred to as a 3 sigma process (ASQ, 2003).

Sigma Level or Sigma Quality Level: Quality calculated to describe the capability of a process to meet specification. Sigma levels (ASQ, 2003):

One Sigma	= 691,500 per million units.
Two Sigma	= 308,500 per million units.
Three Sigma	= 66,810 per million units.
Four Sigma	= 6,210 per million units.
Five Sigma	= 233 per million units.
Six Sigma	= 3.4 per million units.

Six Sigma: Simply, Six Sigma is a highly disciplined approach to decision making that helps people focus on improving processes to make them as near perfect as possible. The term 'Six Sigma' relates to the number of mathematical defects in a process. Six Sigma focuses on systematically eliminating the defects so it can get as close to 'zero defects' as possible. Done properly, Six Sigma ensures that internal processes are running at optimum efficiency. A proven and prescriptive set of analytical tools, project control techniques, reporting methods and management techniques that combine to form breakthrough improvements in problem solving and business performance. A statistical concept that measures a process in terms of defects - at the Six Sigma level, there are only 3.4 DPMO. Also a philosophy of managing that focuses on eliminating defects through practices that emphasise understanding, measuring and improving processes (ASQ, 2003). A term that emphasises the improvement of processes for the purpose of reducing variability and making general improvements. A vision of quality which equates with only 3.4 DPMO for each product or service transaction. It strives for perfection. A structured application of tools and techniques on a project basis, to achieve sustained strategic results and is a methodology that provides businesses with the tools to improve the capability of their business processes. This increase in performance and decrease in process variation leads to defect reduction and improvement in profits, employee morale and quality of product (ASQ, 2003). The term Six Sigma quality is generally used to indicate a process is well controlled (±6 sigma from centreline in a control chart). It is usually associated with Motorola, which named one of its key operational initiatives 'Six Sigma quality' (ASQ, 2003).

Six Sigma Leader: Individual who leads implementation of Six Sigma, coordinating all necessary activities and ensures optimal results are obtained and keeps everyone informed of progress (ASQ, 2003).

Variance: Change in process or business practice that may alter its expected outcome. A measure of deviation from the mean in a sample or population and is the square of the standard deviation (ASQ, 2003).

Variation: Any quantifiable difference between a specified measurement or standard and the deviation from such measurement or standard in the output of a process. Variation in outputs can result from many causes in the functioning and management of processes. An important goal of process improvement is to reduce variation in outputs (ASQ, 2003).

Voice of the Customer (VOC): Describes the stated and unstated needs or requirements of the customer. The voice of the customer can be captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, complaint logs, etc.. VOC represents expressed and non-expressed needs, wants and desires of the recipient of a process output, a product or a service; usually expressed as specifications, requirements or expectations. Customer feedback, both positive and negative, including likes, dislikes, problems and suggestions (ASQ, 2003).

Yellow Belt (YB): Typically has a basic knowledge of Six Sigma but does not lead projects on his/her own, as does a GB or BB. He/she receives approximately one week of training in Six Sigma problem solving and process optimisation methods. YBs participate in process management activities, in GB and BB projects and apply concepts to their work area and their job. YBs generally have some knowledge of Six Sigma but do not act as sole project leader. YBs participate in Six Sigma projects as subject matter experts, core team members and process map developers. Often involved in applying principles of Six Sigma to smaller process improvement projects within the framework of larger implementation (ASQ, 2003).

CHAPTER 1

INTRODUCTION
AND
OVERVIEW OF RESEARCH

CHAPTER 1

INTRODUCTION AND OVERVIEW OF RESEARCH

1.1 Introduction

This introductory chapter presents an introduction and an overview of the whole thesis. First, it gives a background for the research and it summarises the research problems (research gap). Then, it presents research questions, research aim and objectives and research scope, respectively. In addition, it overviews the research design and methodology. Furthermore, it discusses the significance of the research and outlines the thesis structure. Finally, it concludes with a chapter summary. Figure 1.1 shows the structure of the chapter.

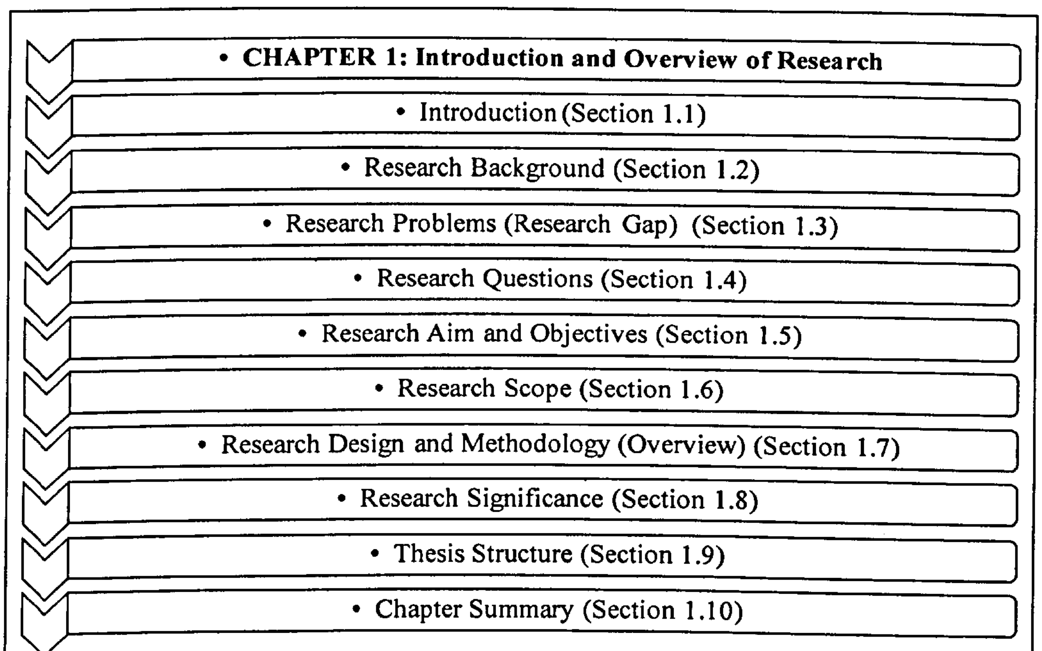


Figure 1.1: Structure of Chapter 1

1.2 Research Background

Today, the current globalisation competitive marketplace and economic pressures have obliged organisations to be cost effective and responsive to customers' needs and this has forced all businesses, regardless of sector or size, domestically and globally, to strive to obtain and sustain a competitive advantage. Many quality management, improvement and strategy initiatives have been proposed to improve the competitiveness of businesses. Total Quality Management (TQM), Business

Process Reengineering (BPR), Kaizen, Benchmarking, Balanced Scorecards, Business Excellence Models and other improvement programmes have been adopted. Six Sigma is another initiative which emerged as a quality management, improvement and strategy programme that has been extensively applied around the world. It aimed at achieving significant improvements in business performance by improving the quality of products and services, reducing costs and shortening lead times because high quality products and low operation costs are the essential ways that help organisations in surviving in the global market. It focuses on process improvement needed for organisational and cultural change, radical enhancement in organisational performance in quality and cost, education and training, customer needs and a team-based approach. It provides a rigorous and strategic approach to achieve organisational performance excellence through the effective use of statistical and non-statistical tools and techniques (Breyfogle *et al.*, 2001a; Antony, 2004b). In addition, as a process improvement methodology, it has become a strong reference for the industrial quality and the business management that can cut costs and eliminate defects from manufacturing and servicing processes (Antony and Fergusson, 2004).

Six Sigma is the newest comprehensive quality improvement and strategic programme which helps organisations increase both customer satisfaction and financial benefits in manufacturing, services-oriented, large organisations and small and medium-sized enterprises (SMEs) to achieve significant improvements in their market share, customer satisfaction, product reliability, service quality, etc., with impressive financial savings (Pyzdek, 1999; Harry and Schroeder, 2000; Snee, 2000b; Breyfogle *et al.*, 2001b; Tennant, 2002). It seeks to find and eliminate causes of defects or mistakes in business processes by focusing on outputs important to customers (Snee, 2000a; Antony and Fergusson, 2004).

Middle East industries, with no exception, are also faced with increasing domestic and international market competition. Recently, therefore, Middle East organisations have been focusing on the importance of quality and have realised the need to improve business activities by continually improving quality, reconsidering inefficient and wasteful manufacturing products and providing services. In addition, in order to do that, they have identified the need to reduce cost and at the same time improve quality, efficiency, productivity and customer satisfaction in order to stay competitive. So, many Middle East organisations have an increased interest in Six Sigma implementation and many have gained the profits and advantages from this disciplined approach and addressed high quality standards, cost effectiveness, process efficiency and improvement and customer satisfaction.

1.3 Research Problems (Research Gap)

Based on the previous research background and the extensive reviewing of the existing literature of the Six Sigma initiative, the problems of this research can be summarised as follows:

- More and more Middle East organisations of different sizes and from different sectors are implementing or beginning to implement a Six Sigma programme and many have gained profits and advantages from this disciplined approach, but they have not yet been investigated empirically.
- The current literature review of Six Sigma reveals that there are many shortcomings in what has been researched to date. It is evident that almost all of the studies and research on Six Sigma implementation have been in developed countries such as the USA, Europe or Japan, and (to the knowledge of the researcher) there has been no single study of Six Sigma in developing countries, such as in the Middle East. In addition, most studies are based exclusively on a one country data set instead of broader data.
- To the researcher's knowledge, no comprehensive or solid theoretical and empirical research has focused on the Six Sigma implementation in the Middle East organisations.

So there is an urgent need to carry out a systematic empirical research analysis of Six Sigma implementation in the Middle East organisations, while taking into consideration that the Middle East is still a beginner in implementing quality processes in business and is in its infancy in this area. It will be more beneficial to expand the research to include a comparative study between the three Middle East countries (Saudi Arabia, Egypt and UAE) implementing the Six Sigma programme in order to get the greatest possible benefits and to transfer the techniques for doing business to the Middle East organisations. Thus, this study intends to bridge the gap in the literature. The researcher believes that it is therefore time to investigate Six Sigma implementation in the Middle East and learn from it.

1.4 Research Questions

Based on the statement of the research problems (research gap), this study intends to cover critical angles for the implementation of Six Sigma in the Middle East and seeks to answer the following main research question (RQ):

RQ: How far are the Middle East organisations from being Six Sigma ones?

Besides this main question, the following six research sub-questions (RQs) also arise to be answered:

RQ1: What is the current status of Six Sigma implementation in the Middle East context?

RQ2: What are the reasons/benefits that encourage organisations to implement Six Sigma projects in the Middle East context?

RQ3: What are the challenges that might be commonly encountered during implementation of Six Sigma projects in Middle East context?

RQ4: What are the critical success factors (CSFs) for the effective implementation of Six Sigma projects in the Middle East context?

RQ5: What is the level of organisations' satisfaction with their implementation of Six Sigma projects in the Middle East context?

RQ6: How could Six Sigma projects be implemented successfully and effectively in the Middle East context?

1.5 Research Aim and Objectives

The aim of this empirical research is exploring and gaining a richer picture of the current status of the implementation of Six Sigma in Middle East organisations to identify a comprehensive set of potential determinants influencing the successful implementation of a Six Sigma project. In addition, determining an answer to the research sub-questions and contributing to the body of knowledge in the Six Sigma field by With this aim in view, the specific objectives of the research (ROs) can be summarised as follows:

1. *In order to answer RQ1:*
   - RO1: To give a clear profile of the organisations that have implemented or are implementing Six Sigma projects by determining the organisations' locality (Saudi Arabia, Egypt or UAE), sector (manufacturing or services) and size - according to number of employees (large organisation or SME).
   - RO2: To give a clear profile of the personnel responsible for Six Sigma implementation by determining their nationality (national or non-national), their organisational position (managerial or operational), their Six Sigma role (top management, Champion, MBB, BB, GB), time spent in the organisations, time as Six Sigma certified/qualified or familiar with it and number of involvements in Six Sigma projects.
   - RO3: To give a clear profile of the Six Sigma programme by determining when it was initiated, who was its primary responsible and what other quality initiatives had been implemented or were being implemented at the time of initiation of the programme.
   - RO4: To give a clear profile of the Six Sigma implementation by determining the present status of implementation, how many projects had been implemented so far in each organisation, the completion time in months of projects implemented, the percentage of employees involved in implementation, the level of organisational resistance to the programme and the importance of the use of external consultants in the planning and implementation of Six Sigma in the organisations.

2. *In order to answer RQ2:*
   - RO5: To determine and highlight the significant reasons/benefits that encourage organisations to implement Six Sigma projects in the Middle East.

3. *In order to answer RQ3:*
   - RO6: To determine and highlight the major challenges (difficulties and barriers) commonly encountered during the implementation of Six Sigma projects in the Middle East organisations.

4. *In order to answer RQ4:*

- RO7: To identify the CSFs that impact on the effective implementation of Six Sigma in Middle East organisations.

5. *In order to answer RQ5:*
   - RO8: To measure the organisations' level of satisfaction with implementation of Six Sigma in the Middle East context.

6. *In order to answer RQ6:*
   - RO9: To learn from best practices and to develop and propose a generic model for successful and effective implementation of Six Sigma in the Middle East. In addition, to make some recommendations to Middle East organisations for successful and effective Six Sigma implementation that include good reasons and full benefits from implementation, solutions to existing challenges of implementation and recommendations for effective consideration of CSFs of Six Sigma.

1.6 Research Scope

This research covers manufacturing and services sectors and large, small, and medium enterprises (SME) sizes (44 organisations) which have implemented or are implementing Six Sigma projects in three countries of the Middle East (Saudi Arabia, Egypt and United Arab Emirates) at the time of study. Although Egypt is a North African country geographically, it can also be considered as a Middle East country, since it has the same or similar base of infrastructure, culture, religion, values and management approach. The reason for choosing these three countries as the context of study is because of their economic success and their implementing of Six Sigma projects in the Middle East, in addition to their importance to the Middle East economy and their accessibility. Therefore, they would be a good point for research to compare and contrast findings from slightly different national cultures.

1.7 Research Design and Methodology (Overview)

To achieve the research objectives, suitable research methodology and research processes have been explored. This section overviews the research design and the methodologies used in the data collection and analysis, with full details of the research methodology for this study discussed at length in Chapter 5. It has been argued that quantitative research is confirmatory and deductive in nature, whilst qualitative research is exploratory and inductive (Trochim, 2001); data from both can be used in a deductive methodology (Yin, 2003). So a methodological triangulation approach combining quantitative (survey questionnaire) and qualitative (semi-structure interviews) methods, as used in this study, has been found to be a very useful method of data collection, as Denzin (1978) mentioned that they complement each other's strengths and weaknesses.

In this study, the unit of sample and analysis is the Six Sigma organisation and top management and Six Sigma certified/qualified personnel of the Middle East organisations. Since the collected data in this study were not normally distributed, non-parametric tests were used. The *SPSS* (Statistical Package for Social Sciences) (version 16) is used for analysis.

Table 1.1 illustrates briefly the design and methodology of this research study. In addition, Figure 1.2 outlines the major steps of the research process.

Table 1.1: Research design and methodology

Research Design and Methodology	
Research social fundamental	Empirical
Research purposes	Exploratory + Comparative
Research strategy	Deductive (Theory-then-Research)
Research philosophy (paradigm)	Mixed (Positivist + Interpretivist)
Research methodological approach	Triangulation (Quantitative + Qualitative)
Data collection types	Secondary + Primary
Data collection methods	Questionnaire + Interview
Sampling type	Non-probability: Purposive (judgement)
Sampling (analysis) units	Six Sigma organisations and their Six Sigma certified/qualified people

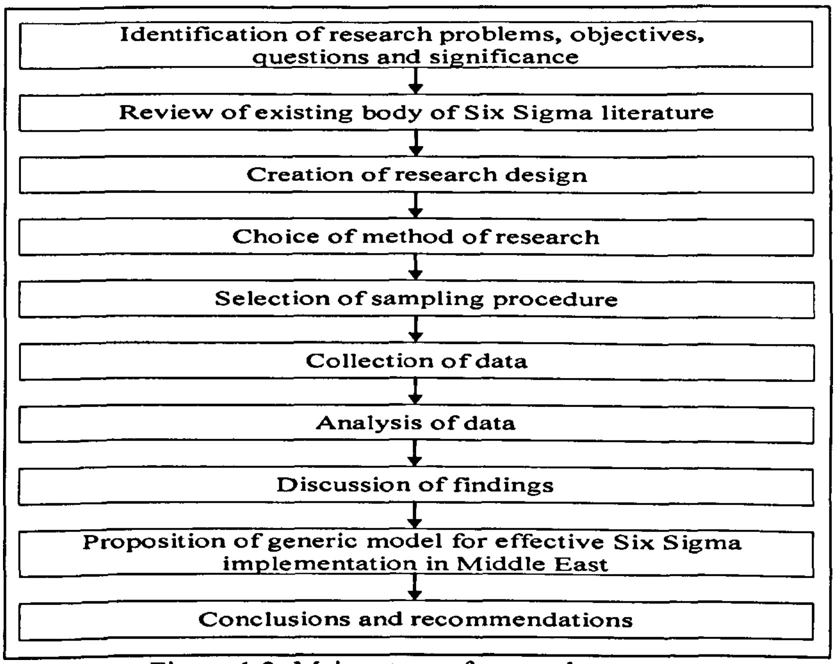


Figure 1.2: Major steps of research process

1.8 Research Significance

The significance of this study comes from the significance of the topic itself which is worth studying for its importance to academics and practitioners (business people). The researcher decided to study Six Sigma implementation in the Middle East context because he expected to gain some advantages for the literature. The topic was deemed to be a good one, especially since Middle East organisations have recently shown interest in Six Sigma implementation. This research investigates empirically the current status of implementation in the Middle East context in order to fill the gap in the current literature where development of empirical research on Six Sigma has lagged behind its fast growing acceptance as a management philosophy for attaining organisational efficiency and effectiveness. The study attempts to bridge this gap.

The significance of this research work can be summarised as follows:

- It adds to the body of knowledge and to literature in the Six Sigma field by filling a gap in the current literature on Six Sigma in the developing countries.
- It is an original attempt, to the best of the researcher's knowledge, based on the literature review of the subject, to investigate Six Sigma practices in the Middle East context.

- As the field of Six Sigma is still not well recognised in the Middle East, this study can be considered as a step towards providing a solid base for further research in this field and guidelines for practitioners in implementing Six Sigma in the Middle East.
- It is considered as one of the first academic studies on Six Sigma in the Middle East, so this study would appear to be unique as well as examining new issues, and comparing and contrasting the efforts of the organisations.
- It explores and provides an empirical investigation of the status of Six Sigma in the Middle East organisations and identifies the essential elements of its implementation including the reasons for them and their benefits, challenges faced and the CSFs in effective Six Sigma implementation.
- It proposes a generic model for successful and effective implementation of Six Sigma in the Middle East.

1.9 Thesis Structure

This thesis is conveniently structured in nine chapters (Figure 1.3), which are designed and developed to achieve its research objectives.

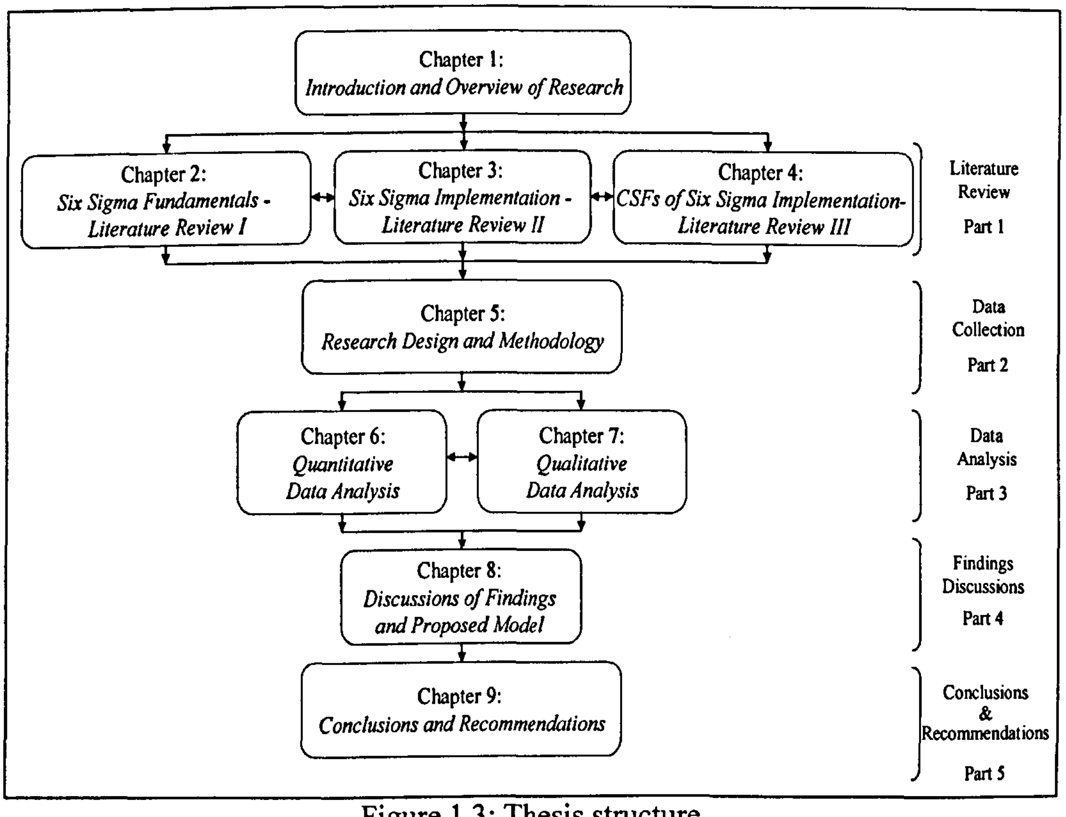


Figure 1.3: Thesis structure

It can be divided into five main parts, excluding this chapter. Part 1 consists of three interconnected chapters, Chapters 2, 3 and 4, aimed at presenting the overall Six Sigma literature review of this study. Part 2 consists of one chapter, Chapter 5, which discusses the research design and methodology. Part 3 has two chapters, Chapters 6 and 7, which discuss the quantitative and qualitative data analysis. Part 4 is comprised of Chapter 8 which focuses on the discussions of findings and the proposed model of the empirical work of the research. In Part 5, Chapter 9 presents the conclusions and recommendations of the research. Each chapter begins with an introduction which briefly describes its contents and ends with a summary. In addition, as much as possible, the study is arranged in such a way that it allows readers to follow the process easily. Finally, the thesis has its bibliography and the eight appendices related to the study.

Chapter 1, *Introduction and Overview of Research*, is dedicated to presenting an introduction and an overview of the whole thesis. First, it gives an introduction to the chapter. Then, it gives background for the research. Next, it outlines the research problems. In addition, it presents research questions, research aims and objectives and research scope, respectively. Also, it overviews the research design and methodology. Furthermore, it discusses the significance of the research. Then, it outlines the thesis structure. Finally, it ends with a summary.

Chapter 2, *Six Sigma Fundamentals*, presents the first part of the literature review. This is a brief overview of the relevant literature related to the Six Sigma fundamentals to build a theoretical foundation for the study. It includes what Six Sigma is (Six Sigma definitions), an overview of Six Sigma origins and the Six Sigma aims, features and principles. Finally, it compares between the Six Sigma and other quality management systems.

Chapter 3, *Six Sigma Implementation*, presents the second part of the literature review, starting with a brief overview of the literature related to Six Sigma implementation. The Six Sigma organisational infrastructure (roles) is briefly outlined, then methodologies used in managing Six Sigma projects for both process improvement and new development projects. In addition, the common reasons for/ benefits of implementing the Six Sigma are given, together with potential challenges in Six Sigma implementation. Finally, reasons for possible failure of Six Sigma implementation projects are presented.

Chapter 4, *Critical Success Factors for Effective Six Sigma Implementation*, presents the third part of the literature review. It deals with the CSFs which affect Six Sigma implementation and drive the success of Six Sigma projects, based on a comprehensive analysis of the Six Sigma literature. It starts with what CSFs are and then it discusses the previous studies of CSFs for Six Sigma implementation. Next, it reviews in detail the CSFs for effective Six Sigma implementation and best practices.

Chapter 5, *Research Design and Methodology*, presents detailed discussions on the research design and methodology issues that the researcher needs to deal with, based on the research objectives and literature review. It explains and discusses the research design and methodology used to accomplish the study objectives. It also explains the reasons for selecting methods for data collection and describes the design of data collection instruments. Also, it describes the justifications and interpretations for choosing the researcher's specified approaches. The rationale for the chosen triangulation design is also highlighted. The pilot research study and the sampling method for the main study are discussed; then, specific steps used in data collection and data analysis. Finally, the research ethical issues are presented.

Chapter 6, *Quantitative Data Analysis*, concerns the quantitative data analysis of the research survey questionnaire. It has two main parts. The first addresses the analysis of the demographic data of the research that give information on the background characteristics of respondents and responding organisations surveyed. The second part focuses on analysis of key issues of Six Sigma implementation of data collected regarding the research questions and their objectives, which are the reasons for/ benefits of Six Sigma implementation, the challenges of implementation, the CSFs for implementation and the satisfaction with implementation in the Middle East.

Chapter 7, *Qualitative Data Analysis*, concerns the qualitative data analyses of the research interviews. It has two main parts. The first addresses the analysis of the demographic data of the research that give information on the background characteristics of interviewees and their organisations. The second part focuses on and analyses key issues of Six Sigma implementation of the data collected regarding the research questions and their objectives, which are the reasons for/ benefits of Six Sigma implementation, the challenges of implementation, the CSFs for implementation and the satisfaction with implementation in the Middle East.

Chapter 8, *Discussion of Findings and Proposed Model*, provides a comprehensive interpretation and discussion of the analysis of the empirical findings of the quantitative and qualitative studies presented in Chapters 6 and 7. Accordingly, it proposes a generic model for successful and effective Six Sigma implementation in the Middle East.

Finally, Chapter 9, *Conclusions and Recommendations*, reviews and summarises the whole of the present research. First, it gives an overview of the research by reviewing the research questions and the research objectives, an overview of the design and methodology, data collection and data analyses used for this research and overviews and summarises the findings of the current research. Then, it gives overall conclusions based on the analysis and the findings of the quantitative and qualitative analysis covered in this study. In addition, it provides the contributions of this research, divided into contributions to literature, methodological contributions and practical contributions. Fourth, it highlights limitations of the research. Fifth, it gives recommendations based on the findings of this investigation and then offers suggestions and directions for future research. It then closes with some concluding remarks.

1.10 Chapter Summary

This chapter introduced and outlined the present thesis by discussing the issues raised and investigated in this research work. In this chapter, a brief background to the research was given, followed by a statement of research problems which were highlighted and discussed. The research questions developed and research aims and objectives were discussed, followed by the scope of research. The design and methodology adopted for the study were then briefly described. In addition, there was a discussion of the significance of the research. Finally, it provided an outline of the structure of the thesis. The next three chapters (Chapters 2, 3 and 4) will provide a review of the relevant literature upon which this thesis is built.

CHAPTER 2

SIX SIGMA FUNDAMENTALS

LITERATURE REVIEW I

CHAPTER 2

LITERATURE REVIEW I - SIX SIGMA FUNDAMENTALS

2.1 Introduction

This chapter presents the first part of the literature review of the current study, with a brief overview of the literature related to Six Sigma fundamentals to build a theoretical foundation for this study. First, it presents what Six Sigma is (Six Sigma definitions). Second, it gives an overview of the origin of Six Sigma. Third, it presents the Six Sigma aims. Fourth, it provides the features of Six Sigma. Fifth, it provides the Six Sigma principles, concepts and key elements. Sixth, it compares between Six Sigma and other quality management systems. Finally, the chapter concludes with a summary. Figure 2.1 shows the structure of the chapter.

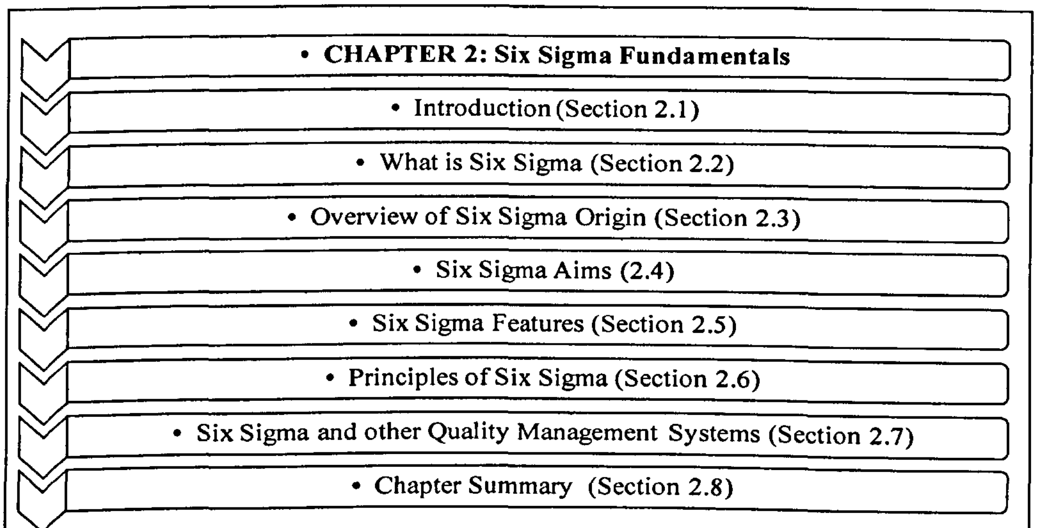


Figure 2.1: Structure of Chapter 2

2.2 What is Six Sigma (6σ)?

Before presenting what Six Sigma is, it is important to explain what sigma is. The sigma term is simply a lowercase letter of the Greek alphabet (σ) related to the statistical measure standard error (SE) or standard deviation (SD) (Keller, 2005). It measures the variability or spread of the data variability from the mean, so the smaller the variation, the lower the cost (Pyzdek 1999; Pande and Holpp, 2002a; Pande *et al.* 2000). In other words, sigma is a statistical term for a measure of how far a given process deviates from perfection or acceptable customer expectations. So it represents the distance between a process or product/service average and the customer's requirement for that process or product/service. It thus signifies how well a business process, product or service is meeting the requirements of the marketplace (Smith *et al.*, 2003). It is measured as a sigma quality level that offers an indicator of how often defects are likely to occur, where a higher sigma quality level indicates a process that is less likely to create them. So it is often used in a scale for levels of goodness or quality. Consequently, the greater (higher) the sigma, the fewer the defects, the better the process (Pande and Holpp, 2002b; Breyfogle, 2003a; Process Quality Associates, Inc., 2004). The sigma level is a measure of how well a critical characteristic performs compared to its requirements. The higher it is, the more capable the characteristic.

Now what is Six Sigma? While some literature refers the use of the term to business improvement methodology (Harry and Schroeder, 2000; Motorola University, 2005), elsewhere the term refers to a statistical measurement tool (Behara *et al.*, 1995) and others refer to it as business strategy (Harry 1998). Six Sigma is a management approach that enhances organisational excellence. It is not just a technical programme but a management programme (Pyzdek, 1999). Therefore Six Sigma can be defined in both statistical and business terms. So the literature review of this study will review most of the Six Sigma definitions from those two perspectives of statistics and business.

2.2.1 Statistical Perspective of Six Sigma

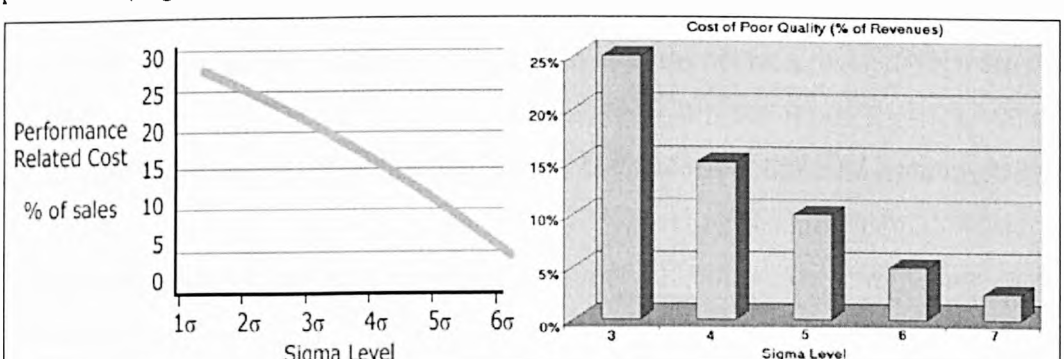
According to Antony (2000) and Antony and Banuelas (2002), Six Sigma is "A statistical quality standard that specifically refers to a performance target of less than or 3.4 defects per million opportunities (DPMO) (or a success rate of 99.99966 per cent accuracy), which is as close as anyone is likely to get to perfect. A defect can be anything from a faulty part to an incorrect customer bill". Defects can lead to lost customers, particularly when customers tell others about their experiences. Six Sigma uses metrics such as DPMO or yield to set specific, quantitative and challenging goals. These metrics are used to direct the planning of an improvement project, to track the project's progress and to quantify and evaluate the project's outcomes (Pande *et al.*, 2000). Table 2.1 illustrates the relationship between Sigma quality level, DPMO and equivalent short/long-term yield and related cost of poor quality as well the business standard.

Table 2.1: Relationship between Sigma quality level, DPMO, equivalent short/long-term yield and related cost of quality

Sigma quality level (value)	Short-Term Process Capability (Process mean, fixed)		Long-Term Process Capability (Process mean, with 1.5σ shift)		Cost of Poor Quality (COPQ)	Business Standards
	% Good	DPMO	% Good	DPMO		
1σ	68.26894	317,311	30.2328	691,500	---	---
2σ	95.44998	45,500	69.1230	308,500	>40%	---
3σ	99.73002	2,700	93.3189	66,810	25-40%	Unsatisfactory
4σ	99.99366	63.4	99.3790	6,210	15-25%	Old Standards
5σ	99.999943	0.57	99.97674	233	5-15%	High-Class
6σ	99.9999998	0.002	99.99966	3.4	<5%	World-Class

Source: Antony and Banuelas (2001), Pande and Holpp (2002a)

Pyzdek (2003a) claimed that there is a clear connection between which sigma level an organisation is operating at and the cost of poor quality (COPQ). The cost of non-quality in organisations that do not use Six Sigma is extremely high compared to those which are implementing it. Organisations operating at three sigma (3σ) level typically spend between 25 and 40 per cent of their revenues fixing problems. This is known as the cost of quality or, more accurately, the COPQ. It is often quoted that the cost of non-quality in organisations operating with 3σ standards will be in the order of 25-40 per cent of their revenues, while organisations operating at Six Sigma, on the other hand, tend to spend less than 5 per cent of their revenues fixing problems (Figure 2.2).



Source: Pyzdek (2003a)

Figure 2.2: Sigma level versus cost of poor quality (COPC)

The cost of this gap can be huge. General Electric (GE) estimates that the gap between 3σ or 4σ and Six Sigma was costing them between US$8 and US$12 billion per year (GE, 1997).

Currently, according to Pande and Holpp (2002b), most businesses actually operate at 3σ to 4σ standards which translate into about 66,810 to 6,210 DPMO (which incidentally is also generally considered to be an unsustainable level of customer satisfaction). Operating at 3.8σ means getting it right 99% of the time. A measurement of 4σ equates to approximately 6,210 DPMO or around 99.4% perfection. This would arguably be an acceptable level of quality in certain types of business, but a 99.4% success rate is obviously an unacceptable level of quality in others. 1σ, for example, means 691,500 DPMO. At 2σ, an organisation could be making 300,000 DPMO. That is simply not good enough in today's economy; this means 25% of revenues are spent fixing defects. This is known as the COPQ. If an organisation can improve its quality by 1 sigma level, its net income will increase hugely, approximately 10 per cent net income improvement (see Table 2.1). Six Sigma leads to cost savings, quality of product/service enhancement and ultimately customer satisfaction. The DPMO values and sigma values can be viewed in Appendix C.

Harry (1987) and McClusky (2000) illustrated why 99% quality level (3.8σ) is not acceptable and the following facts are considered:

- At major airports, 99% quality means two unsafe plane landings per day.
- In mail processing, 99% quality means 16,000 pieces of lost mail every hour.
- In power generation, 99% quality will result in 7 hours of no electricity each month.
- In water supply, 99% quality means unsafe drinking water almost 15 minutes per day.
- In medical surgery, 99% quality means 500 incorrect surgical operations per week.
- In medication for patients, 99% quality means 200,000 wrong drug prescriptions each year.

Based on world-class process performance and statistical analysis of real-world processes, the Six Sigma quality levels relate better to customer expectations. "Five Sigma will not meet customer requirements and seven will not add significant value. Six Sigma's 3.4 DPMO is close to perfection, and that makes it a more attainable and realistic goal to achieve." (Adams *et al.*, 2003).

2.2.2 Business Perspective of Six Sigma

There is no standard definition for the business perspective of Six Sigma and there are many interpretation and definitions offered by different people. But all definitions represent an improvement strategy process, quality measurement, quality initiative, a goal-driven management system and problem-solving improvement tool. Table 2.2 gives a chronological summary of 46 selected Six Sigma definitions in the literature.

Table 2.2: Summary of 46 selected Six Sigma definitions in literature

No.	Author(s)	Six Sigma Definition
1	Kumar and Gupta (1993)	"A quality-focused programme that ensures that a maximum of 3.4 DPMO are defective in each step of the process."
2	McFadden (1993)	"A customer-driven approach that provides an overall framework for quality management."
3	Behara *et al.* (1995)	"A way of measuring the probability that companies can manufacture any given unit of a product or service with zero defects."
4	Behara *et al.* (1995)	"The rating that signifies 'Best in Class' with only 3.4 DPMO, which approaches to zero defects."
5	General Electric (1997)	"A highly disciplined process that helps and focuses on developing and delivering near-perfect products and services."
6	Bolze (1998)	"A formal methodology for measuring, analysing, improving, and then controlling processes."
7	Harry (1998)	"A way of measuring process, it measures of process performance and a process operating at Six Sigma quality has a defect rate of 3.4 DPMO."
8	Hendricks and Kelbaugh (1998)	"A data-driven methodology for reducing waste, increasing customers' satisfaction and improving processes with a focus on financially measurable results."
9	Hoerl (1998b)	"A formal and disciplined methodology for defining, measuring, analysing, improving and controlling processes. The fundamental idea behind the Six Sigma philosophy is to continuously reduce variation in processes and aim at the elimination of defects or failures from every product, service and transactional process."
10	Murphy (1998)	"A quality initiative that applies statistical measurements to achieve 3.4 defective parts per million - essentially an elimination of errors."
11	Snee (1999)	"A business approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on outputs that are critical importance to customers."
12	Snee (1999)	"A strategic business improvement approach that seeks to increase the customer satisfaction and financial health of an organisation."
13	Buggie (2000)	"A disciplined method of using very rigorous data gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them."
14	Harry and Schroeder (2000)	"The strategy that provides organisations with a series of interventions and statistical tools that can lead to breakthrough profitability and quantum gains in quality, whether an organisation's products are goods or services."

(continued)

Table 2.2: (continued)

No.	Author(s)	Six Sigma Definition
15	Harry and Schroeder (2000)	"A business process that allows organisations to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimise waste and resources while increasing customer satisfaction."
16	Henderson and Evans (2000)	"A quality improvement programme to reduce the number of defects to as low as 3.4 DPMO."
17	Pande and Holpp (2000)	"A smarter way to manage business; it puts the customer first and uses facts and data to drive better solutions."
18	Pande *et al.* (2000)	"A business system for achieving and sustaining success though customer focus, process management and improvement, and the wise use of facts and data."
19	Pande *et al.* (2000)	"A broad and comprehensive system for building and sustaining business performance, success, and leadership. In other words, Six Sigma is a management 'best practices' and concepts, including systems thinking, continuous improvement, knowledge management, mass customisation, and activity-based management."
20	Pande *et al.* (2000)	"A way of measuring processes, a goal of near perfection, represented by 3.4 DPMO and it is an approach to changing the culture of an organisation."
21	Pande *et al.* (2000)	"A comprehensive and flexible system for achieving, sustaining and maximising business success. It is uniquely driven by close understanding and customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business process."
22	Pande *et al.* (2000)	"An extensive culture change effort to position an organisation for greater customer satisfaction, profitability, and competitiveness."
23	American Society for Quality (ASQ) (2001)	"A system for improving the quality of organisational processes and products to 3.4 defects per million by identifying and removing process and product variation."
24	Antony and Banuelas (2001)	"A business improvement strategy used to improve business profitability, to drive out waste, to reduce costs of poor quality and to improve the effectiveness and efficiency of all operations so as to meet or even exceed customers' needs and expectations."
25	Breyfogle *et al.* (2001a)	"A rigorous application of statistical tools throughout an organisation."
26	Breyfogle *et al.* (2001a)	"A quality programme that provides a rigorous approach to achieve organisational performance excellence."
27	Breyfogle *et al.* (2001b)	"An intelligent blending of the wisdom of the organisation with proven statistical tools to improve both the efficiency and effectiveness of the organisation in meeting customer needs. The ultimate goal is not improvement for improvement's sake, but rather the creation of economic wealth for the customer and provider alike."
28	Breyfogle *et al.* (2001b)	"An overall business strategy. It is not only statistical techniques used in the organisations, neither is it the sophisticated version of TQM, but a combination of both. Six Sigma is perceived as a 'strategic initiative' rather than a 'quality programme."
29	Tennant (2001)	"A new paradigm of customer satisfaction, it is a statistically based measurement scale, and it is a methodology by which quality can be improved. It is definitely not simply a shift in statistical methods and accounting from 'three Sigma to Six Sigma."
30	Watson (2001)	"Six Sigma is not simply a set of tools or another quality programme; rather, it is a way of doing businesses for greater customer satisfaction, profitability, and competitiveness."

(continued)

Table 2.2: (continued)

No.	Author(s)	Six Sigma Definition
31	Antony (2002)	"A rigorous and disciplined methodology that uses data and statistical analysis to measure and improve an organisation's operational performance by identifying and eliminating defects in manufacturing and service-related processes."
32	Antony and Banuelas (2002)	"A strategic quality programme that stresses the application of statistical and problem-solving tools and techniques in a methodical and systematic manner to achieve improvements in the quality of organisations' products and services and their bottom-line results."
33	Coronado and Antony (2002)	"A quality management system of problem solving. By applying many quality tools and techniques, Six Sigma makes people look at the problem from all the different angles in order to consider everything as important."
34	Pande and Holpp (2002)	"A total management commitment and philosophy of excellence, customer focus, process improvement and the rule of measurement rather than gut feel. Six Sigma is about making every area of the organisation better able to meet the changing needs of customers, markets, and technologies with benefits for employees, customers, and shareholders."
35	Pande and Holpp (2002)	"Six Sigma is not only a statistical programme, but also a business initiative; the real message of Six Sigma goes beyond statistics. Six Sigma is a total management commitment and philosophy of excellence, customer focus, process improvement and the rule of measurement rather than gut feel."
36	Chowdhury (2002)	"A quality improvement programme; it is more than a set of tools, it is a management philosophy that focuses on eliminating mistakes, waste and rework."
37	Linderman *et al.* (2003)	"An improvement goal, a method, a way of thinking, and an organisation scheme."
38	Linderman *et al.* (2003)	"An organised and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates."
39	Brue (2003b)	"A methodology which provides a logical sequence of steps to uncover vital knowledge about the service or manufacturing process in question. It provides a systematic method to find, quantify and 'translate that knowledge into opportunities for business growth,' and well as power over the process."
40	Snee (2003)	"A business improvement strategy that seeks to find and eliminate causes of defects or mistakes in business processes by focusing on outputs that are of critical importance to customers It is a powerful approach to process improvement, reduced costs and increased business profitability and revenue growth."
41	Antony (2004a)	"A business strategy which seeks to identify the causes of errors and remove or identify the defects and failures in the business process through the outputs related to customer's needs. Moreover, Six Sigma measures the quality which struggle to eliminate the defect using different statistical techniques. It is worth mentioning that defect means anything that leads to customer's dissatisfaction."
42	Antony (2004a)	"A powerful business strategy that employs a disciplined approach to tackle process variability using the application of statistical and non-statistical tools and techniques in a rigorous manner."
43	Antony (2004b)	"A measure of quality that strives for near elimination of defects using the application of statistical methods."

(continued)

Table 2.2: (continued)

No.	Author(s)	Six Sigma Definition
44	Hearing (2004)	"A quality improvement process organised around individual projects with finite timelines, each project beginning by forming a team to identify the customer and the customer's needs."
45	American Society for Quality (ASQ) (2005)	"A methodology that provides businesses with the tools to improve the capability of their business processes."
46	Tadikamala (2005)	"A quality improvement programme with a goal of reducing the number of defects to as low as 3.4 DPMO. It uses the normal distribution and strong relationships between product nonconformities or defects and product yield, reliability, cycle time, inventory, schedule, and so on."

Pande and Holpp (2002a) stated that "In fact, the Six Sigma methodology is a better way to manage a business and puts the customer first and uses data and facts to drive a better solution". The Six Sigma concept addresses quality in all aspects of the business: products and services, manufacturing, administration and operations (Motwani *et al.*, 2004). Pande *et al.* (2000) defined a Six Sigma organisation as "An organisation that is actively working to build the themes and practices of Six Sigma into its daily management activities, and is showing significant improvements in process performance and customer satisfaction." In addition, Breyfogle *et al.* (2003b) found that the strength behind Six Sigma business strategy was that it focused on objectives that were vitally important to the needs of the organisation.

Pande *et al.* (2002) argued that Six Sigma process improvements are based around three key elements of quality:

1. *Customers*: who expect performance, reliability, competitive prices, on-time delivery, and service.
2. *Processes*: looked at from the customer's perspective to add significant value or improvement.
3. *Employee commitment*: maximising their talents and energies on customer satisfaction and meeting Six Sigma status.

2.3 Overview of Six Sigma Origin

The concept of Six Sigma (6σ) was pioneered and originally developed by the Motorola Corporation in the mid-1980s, with the aim of dramatically reducing quality costs by eliminating variations in processes (i.e. costs of not doing things right first time, costs of not meeting customer requirements, etc.) (Antony 2004a). It was focused on manufacturing processes with the aim of continuously reducing defects throughout the organisation's processes and rapidly expanded to other industries with customer satisfaction as the primary measure of quality. After Motorola, Six Sigma has been implemented by a number of world class organisations such as General Electric (GE), AlliedSignal (or Honeywell today), Texas Instruments, Ford, Toyota, Sony, Hewlett Packard, Eastman Kodak, Caterpillar, Jaguar, Raytheon, Lockheed-Martin, Boeing, DuPont, Polaroid, 3M and American Express, with the aim of improving efficiency within business processes, sustaining process changes and reducing loss of time, number of defects, effort and cost and overall, leading to improved quality and ultimately customer satisfaction. Therefore, Six Sigma has appeared on the agenda of many organisational strategies (Antony and Fergusson, 2004; Goffnett, 2004; Kwak and Anbari, 2006).

According to Tennant (2001) and Arnheiter and Maleyeff (2005), Six Sigma roots are traced to two primary sources: Total quality management (TQM) which provides tools and techniques to bring about cultural change and process improvement within an organisation and Six Sigma statistical metric originating at the Motorola Corporation. Oakland (2003) also agreed with the concept that Six Sigma is a combination of TQM and Statistical process control (SPC), a Japanese approach to process improvement and design, customer satisfaction and customer needs analysis, but it is more than TQM or SPC.

Six Sigma is a systematic methodology for continuous process quality improvement and the process of achieving operational excellence. Six Sigma has been on an incredible run for over 15 years, producing significant savings to the bottom line of many large and small organisations (Hoerl, 2004). While the original goal of Six Sigma was to focus on manufacturing processes, today, marketing, purchasing, healthcare, financial services, etc. are also embarked on Six Sigma strategies with the aim of continuously reducing defects throughout the organisation's processes.

2.4 Six Sigma Aims

According to Antony (2004a), the fundamental aim of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects. In addition, "The fundamental idea behind the Six Sigma philosophy is to continuously reduce variation in processes and aims at the elimination of defects or failures from every product, service and transactional process" (Hoerl, 1998a). Another aim of Six Sigma is it nearly targets to defect-free procedures and products or services with 3.4 or fewer defective components per one million chances or DPMO that signifies best in class (Behara *et al.,* 1995; Pande and Holpp, 2002a; McAdam and Lafferty, 2004).

The essential idea of Six Sigma is that if an organisation can measure how many defects can be found in a process, it can systematically figure out how to eliminate them and get as close to zero defects as possible. The goal of Six Sigma is not to achieve Six Sigma levels of quality but to improve profitability and increase profits by eliminating variability, defects and waste that undermine customer loyalty by ensuring almost zero customer defects in core customer processes (Tennant, 2001; Pande and Holpp, 2002b). In addition, Six Sigma aims to ensure that all outputs meet near-perfection of customer specifications and requirements. As Pande and Holpp (2002b) stated, "Achieving the goal of Six Sigma requires more than small and incremental improvement. It requires breakthroughs in every area of an operation". Harry and Schroeder (2000) stated that Six Sigma satisfies the three goals that every organisation struggles to achieve through its vision and commitment. They are:

1. Satisfying internal and external customers including stakeholders and consumers.
2. A closed loop and continuously improving all work processes.
3. Having highly motivated and involved employees.

2.5 Six Sigma Features

Harry and Schroeder (2000) maintained that "Six Sigma is one of the most effective quality improvement strategies developed in a decade before and it sets the standard for all quality efforts now underway". Six Sigma process improvement strategies have in fact come to play a leading role in the quest to improve quality recently. Six Sigma is a methodology which is used more and more in different businesses. Therefore, Six Sigma can be seen and identified as a metric, a philosophy, a vision, a method, a tool, a symbol, a value, a benchmark and a goal (Figure 2.3).

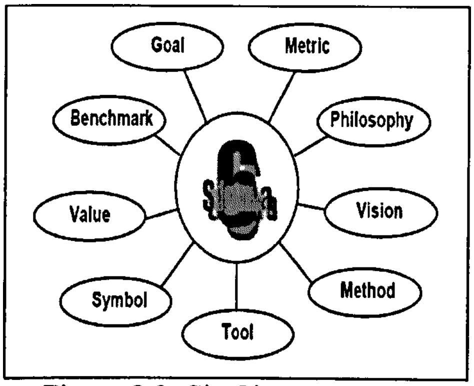


Figure 2.3: Six Sigma Features

Tennant (2001) advocated that "Six Sigma is: a vision, a philosophy, a symbol, a metric, a goal, and a methodology." According to Harry (1998), Breyfogle *et al.* (2001b), Eckes (2001a), Brue (2002a), Pande and Holpp (2002a) and Adams *et al.* (2003), Six Sigma can be viewed as a metric, a mindset and a methodology. Six Sigma, according to Harry (1997), could be:

- A *statistical measurement*: It tells us how good our products, services and processes are.
- A *business strategy*: It can greatly help us gain a competitive edge.
- A *philosophy*: It is an outlook, a way that we perceive and work within the business world.
- A *means*: It links values with actions which, in turn, set improvement in motion.

According to Truscott (2003), Six Sigma is intended to provide a universal performance metric, a world-class performance benchmark and a marketing name for improvement initiative. In addition, he stated that the statistical model is essentially made up of three elements: sigma statistic, sigma measure and performance benchmark.

Snee and Hoerl (2003) stated that Six Sigma can be viewed in three ways: as a philosophy, a methodology and a measurement:

1. *Philosophy:* The focus of Six Sigma is to reduce and control variation and waste in processes based on the importance to the customer.
2. *Methodology:* Six Sigma integrates tools from all continuous improvement initiatives and helps apply them to all business processes. It satisfies five methodologies of defining, measuring, analysing, improving and controlling the performance of the business, referred to as the DMAIC approach for any organisation.
3. *Measurement:* Six Sigma enables to know the effectiveness of eliminating variation and defects from processes. It allows comparison of quality achievement across various products and processes. Measurement of Six Sigma quality levels is represented by 3.4 DPMO to create such defects.

2.6 Principles of Six Sigma

According to Pande *et al.* (2000) and Pande and Holpp (2002), there are some key principles of Six Sigma that are at the heart of the Six Sigma philosophy and shape the definition and practice of Six Sigma as a comprehensive methodology. They are:

1. <u>Genuine focus on customer</u>

In Six Sigma, business improvement is based on the customer requirements and needs. Tennant (2001) emphasises the importance for organisations to identify the customers and their needs and requirements and to transform customer needs into measurable and actionable characteristics. He suggested that customer needs have to be converted into process or product requirements, i. e. critical-to-quality (CTQ) factors, due to the needs of the customers not always being aligned with the real processes issues and it is difficult for them to be engineered into process improvement.

Customer focus is the top priority in Six Sigma. One of the important tasks of the improvement process is to define the customer requirements in order to meet them. Also, the measurement of success in a Six Sigma programme is the defects which fail to meet customer requirements. In other words, Six Sigma begins and ends with the voice of the customer. Customers need systems and strategies that serve to tie in the business to the voice of the customer. So one of the main Six Sigma principles is to put the customer at the forefront of decision making. According to Tennant (2001), the aim of Six Sigma is "to completely satisfy - if not exceed - the customer's requirements." The measures of Six Sigma performance begin with the customer and its improvements are defined by their impact on customer satisfaction and value (Pande *et al.*, 2000).

2. Data and fact-driven management

With Six Sigma, statistics provide objective evidence on which decisions are based and help to identify the key measures which influence business performance and lead to the variations in performance outcomes. Data collection and analysis are required to help the management understand the key variables and optimise results. Other than helping to identify the key variables, Six Sigma also has implications for the use of data and analysis.

Six Sigma teams need to collect and analyse data to understand key variables and process drivers. Management driven by data and facts must exist where an effective measurement system exists to track results and outcomes as well as process. Six Sigma helps managers deal with two essential matters to support data-driven decisions and solutions as follows:

- *Process focus, management and improvement*

In Six Sigma, great emphasis is placed on process which is seen as the key vehicle to success. As described earlier, Six Sigma aims to identify and eliminate the causes of variations in the process. Hence, attention is focused on process improvement and the belief that continuous process improvement could provide organisations with fewer variations in outcome and better production.

Six Sigma focuses on the process, management and improvement as the key means to meet customer requirements; therefore, identifying the core business processes on which customer satisfaction stands is the critical step in Six Sigma teams. Processes in Six Sigma are documented, communicated, measured and refined on an ongoing basis.

- *Proactive management*

Six Sigma is a proactive approach to management. Instead of treating the defects after their occurrence, Six Sigma provides the tools and practices to replace reactive management with proactive management that can identify the problems that could possibly occur. Proactive management is claimed as a good starting point for true creativity, better than bouncing from one panicky crisis to the next. Proactive management, involving habits and practices that anticipate problems and changes, applies facts and data and questions assumptions about goals and 'how we do things'. Proactive management should include defining ambitious goals and reviewing them frequently, setting clear priorities, focusing on problem prevention and questioning why we do things instead of blindly defending them.

3. Boundaryless collaboration

Six Sigma provides a bird's eye view across the processes in the operation and enables people to learn how their work fits into the whole business process. It has been suggested that Six Sigma creates the environment for 'true teamwork,' as instead of competing between teams, people realise and measure the interdependence of activities in all parts of a process and work together to achieve its final aim. Six Sigma requires collaboration as people learn about their roles in the big process picture and connect their relationships to internal and external customers.

Antony *et al.* (2003) identified Six Sigma strategies, principles, tools and techniques, as presented in Table 2.3.

Table 2.3: Six Sigma strategies, principles, tools, and techniques

Six Sigma strategies and principles	Six Sigma tools and techniques
▪ Project management. ▪ Data based decision making. ▪ Knowledge discovery. ▪ Process control planning. ▪ Data collection tools and techniques. ▪ Variability reduction. ▪ Belt system. ▪ DMAIC process. ▪ Change management tools.	▪ Statistical process control. ▪ Process capability analysis. ▪ Measurement system analysis. ▪ Design of experiments. ▪ Robust design. ▪ Quality function deployment. ▪ Failure mode and effect analysis. ▪ Regression analysis. ▪ Analysis of means and variances. ▪ Hypothesis testing. ▪ Root cause analysis. ▪ Process mapping.

Source: Antony *et al.* (2003)

2.7 Six Sigma and other Quality Management Systems (QMSs)

Six Sigma is more comprehensive than prior process improvement initiatives and uses additional, more advanced data analysis tools, project management methodology and tools and includes measured financial results. There are many characteristics and differentiating aspects of the Six Sigma strategy not emphasised in previous quality management and improvement methodologies (Antony, 2004b):

- It places a clear focus on achieving measurable and quantifiable financial returns to the bottom-line of an organisation. No Six Sigma project is approved unless the bottom-line impact has been clearly identified and defined.
- Its methodology has been very successful in integrating the human elements (culture change, customer focus, belt system infrastructure, teamwork, motivation, etc.) and process elements (process management, process improvement, process monitoring and control, statistical analysis of process data, measurement system analysis, etc.) of improvement.
- It integrates both statistical and non-statistical tools of quality improvement in a sequential manner within a powerful problem-solving framework (DMAIC processes).
- It emphasises the importance of data and decision-making based on facts and data rather than assumptions and guesses.
- It places more emphasis on repeatability and reproducibility of the measurement systems needed for operating the business than the little (if any) placed previously. It forces people to put measurements in place.
- It gives an unprecedented importance to strong and passionate leadership and the support required for its successful deployment.
- It builds on improvement methods shown to be effective and integrates human and process aspects of improvement. No other approach integrates these two issues as well as Six Sigma does.
- It develops process improvement specialists dedicated to Six Sigma projects, instead of putting additional tasks on already over-burdened executives.
- Its methodology uses the tools and techniques for fixing problems in business processes in a sequential, disciplined and systematic manner. Each tool and technique within the Six Sigma initiative has a role to play and when, where, why

and how these tools or techniques should be applied is the difference between success and failure of a Six Sigma project.

- It creates a powerful team infrastructure of Project Champions, MBBs, BBs and GBs who lead, deploy and implement the approach.
- It uses the concept of statistical thinking and encourages the application of well-proven statistical tools and techniques for defect reduction through process variability reduction methods (e.g. SPC and design of experiments).
- It focuses on input variables. While traditional process improvement methods depend upon measuring outputs and establishing control plans to shield customers from organisational defects, a Six Sigma programme demands that problems be addressed at the input root cause level, thereby eliminating the need for unnecessary inspection and rework processes.
- It recognises that there is a direct correlation between the number of product defects, wasted operating costs and level of customer satisfaction.

In comparison with traditional approaches of quality management, Six Sigma is business results-oriented and focuses on achieving tangible and measurable benefits by using specific tools, techniques and dedicated professionals to drive out variations from the business processes. In addition, Six Sigma is the most effective concept because of the interrelation between its strategy, organisational structures, procedures, tools and methods (Pfeifer *et al.*, 2004). The Six Sigma approach is created to combine statistical tools, problem-solving tools and clear roadmap. It is not only a quality improvement initiative but also a problem solving technique. Therefore, "Six Sigma is a business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on output that are of critical importance to customer" (Snee 2004). In brief, at the strategic level, the goal of Six Sigma is to align an organisation keenly to its marketplace and deliver real improvements to the bottom-line. On the other hand, at the operational level, Six Sigma's goal is to move business product or service attributes fully within the zone of customer specifications and to dramatically shrink process variation which is the cause of defects which negatively affect customers. The common elements of Six Sigma, TQM and BPR, in addition, comparison between Six Sigma and TQM are summarised in Tables 2.4 and 2.5, respectively.

Table 2.4: Common elements of Six Sigma, TQM and BPR

Element	Six Sigma	TQM	BPR
Focus on customer	✓	✓	✓
Top management involvement and commitment	✓	✓	✓
Culture change	Radical	Incremental	Radical
Communication	✓	✓	✓
Depend on processes	✓	✓	✓
Continuous improvement	✓	✓	✓
IT	Useful	Useful	Enabler
Training	✓	✓	✓

Table 2.5: Comparison between Six Sigma and TQM

Similarities	Dissimilarities
• Both focus on quality control and continuous improvement. • Both focus on organisational culture. • Both do not consider separate quality control system rather emphasise injecting quality concept in all functions of the organisation. • Employee involvement and training are important in both. • Both give high significance to customer satisfaction. • Both demand absolute commitment from top management.	• Six Sigma is more mathematical approach in comparison to TQM. • Six Sigma highlights business results whereas TQM highlights basically quality. • Six Sigma emphasises more than TQM employee training in relation to mathematics, statistics and data analysis. • Six Sigma emphasises executive ownership whereas TQM concentrates more on self-directed work teams. • Six Sigma facilitates efficient project management.

2.8 Chapter Summary

This chapter has presented Six Sigma fundamentals through a brief review of relevant literature to build a theoretical foundation for this study. First, it has presented what Six Sigma is (Six Sigma definitions). Combining the preceding definitions, it could be said that Six Sigma is a data driven, process improvement, problem identification tool that uses both scientific method and statistical analysis to achieve bottom-line results. Six Sigma can be a powerful business strategy that can help organisations in achieving and sustaining operational and service excellence. Then, it has gave an overview of the origin of Six Sigma, it could be said that the. roots of which are traced to TQM which provides tools and techniques to bring about cultural change and process improvement within an organisation, Six Sigma being a combination of TQM and SPC for process improvement and design, customer satisfaction and customer needs analysis. Furthermore, it has presented the Six Sigma aims and provided the features of Six Sigma, it showing that the fundamental idea behind the Six Sigma philosophy is to continuously reduce variation in processes and it aims at the elimination of defects or failures from every product, service to nearly targets to defect-free procedures and products or services with 3.4 or fewer defective components per one million chances that signifies best in class. In addition, it provided the Six Sigma principles, concepts and key elements. Finally, it has compared Six Sigma and other quality management systems and it could be said that Six Sigma is more comprehensive than prior quality management systems and uses additional, more advanced data analysis tools, project management tools and methodology, which includes measured financial results.

As a continuation to the literature reviewed in this chapter, the following chapter (Chapter 3) will focus on Six Sigma implementation.

CHAPTER 3

SIX SIGMA IMPLEMENTATION

LITERATURE REVIEW II

CHAPTER 3

LITERATURE REVIEW II - SIX SIGMA IMPLEMENTATION

3.1 Introduction

This chapter presents the second part of the literature review of the study. It provides a brief overview of the literature related to Six Sigma implementation, starting with a brief introduction of Six Sigma organisational infrastructure (roles). Then, an overview of Six Sigma methodologies used in managing Six Sigma projects for both process improvement and new development projects will be presented and in addition the reasons for/ benefits of the Six Sigma implementation. Furthermore, common challenges in Six Sigma implementation will be discussed. Then, reasons for possible failure of Six Sigma implementation projects will be presented. Finally, the chapter ends with a summary. Figure 3.1 gives the structure of the chapter.

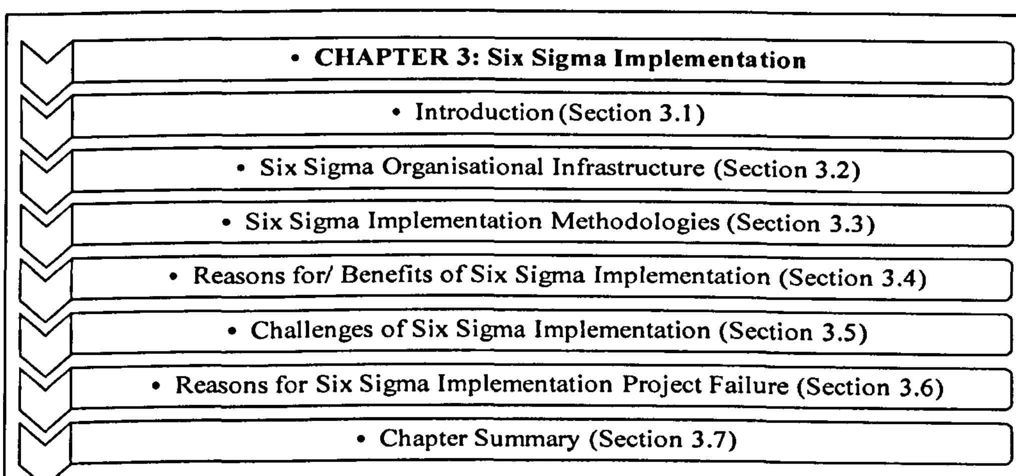


Figure 3.1: Structure of Chapter 3

3.2 Six Sigma Organisational Infrastructure (Roles)

The Six Sigma implementation is carried out through a unique solid infrastructure classification hierarchy system of roles and involvement for management and employees depending on their different levels of expertise known as the Belt System (Hahn *et al.*, 2000; Pande *et al.*, 2000; Pyzdek, 2000c; Eckes, 2001a; Hoerl, 2001; Brue, 2002b; Pande *et al.*, 2002; Adams *et al.*, 2003; Breyfogle *et al.*, 2003a). It consists of key players given special titles of martial arts colour belts based on their skills as Champion, Master Black Belt (MBB), Black Belt (BB), Green Belt (GB) and Yellow Belt (YB), who is also known as team member. Table 3.1 provides a comparison of the roles played by main participants in Six Sigma projects with those in traditional projects. Figure 3.2 presents the Six Sigma programme infrastructure classification hierarchy. Full details of the Six Sigma Belt System roles are given in the Glossary of Six Sigma Terms.

Table 3.1: Roles of participants in Six Sigma and traditional projects

Six Sigma Project	Traditional Project
Champion	Project sponsor
Master Black Belt	Project management officer
Black Belt	Project manager
Green Belt	Specialised project team member
Yellow Belt (team member)	Project team member

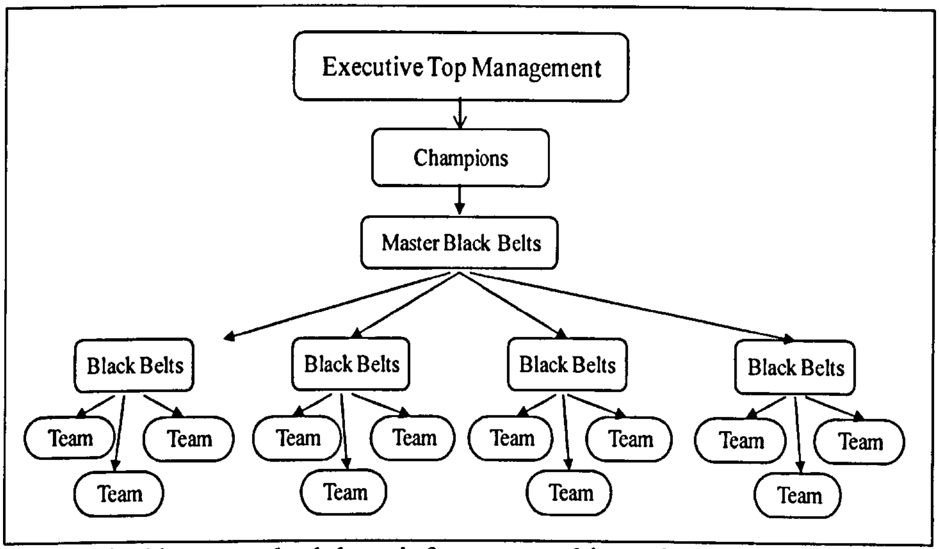
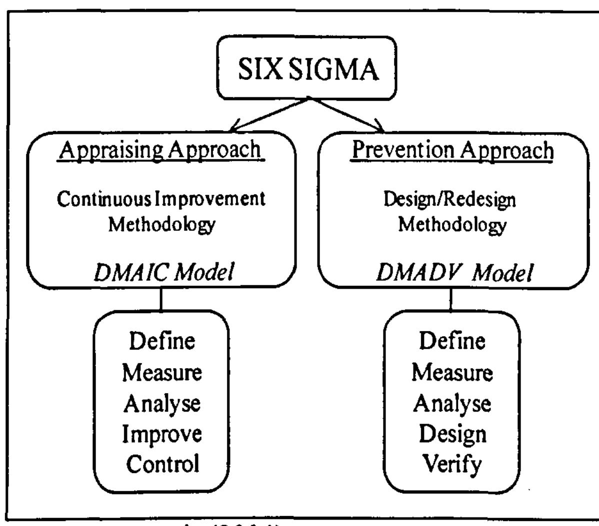


Figure 3.2: Six Sigma methodology infrastructure hierarchy classification hierarchy system

In Six Sigma organisations, each belt represents a different skill level, which is achieved through training and practice. Each belt receives training in leadership skills, technical skills and soft skills (e.g. communication, mentoring, etc.) of employees (Snee and Hoerl, 2003). Every player in the team has a specific role, clearly defined, with consequences for not coming through and rewards for doing his/her particular job well. Pyzdek (2000b) suggested that having a proper infrastructure to guide and raise the introduction and implementation of Six Sigma in an organisation is one of the major critical factors that would impact on its success or failure.

3.3 Six Sigma Implementation Methodologies

The Six Sigma methodologies are either a *continuous improvement methodology (DMAIC)* (appraisal approach) or a *design/redesign* (design for Six Sigma (DFSS)) *methodology (DMADV)* (prevention approach) (Stamatis, 2004), as shown in Figure 3.3. The DMAIC methodology should be used when a product or process is in existence but is not meeting customer specifications or is not performing adequately. The DMADV methodology, on the other hand, should be used when a product or process is not in existence and when one needs to be developed or the existing product or process exists and has been optimised but still does not meet the level of customer specification or Six Sigma level.



Source: Stamatis (2004)

Figure 3.3: Six Sigma methodologies

The Six Sigma DMAIC continuous improvement methodology is at the heart of the Six Sigma implementation programme. DMAIC stands for the five interconnected processes (phases) improvement approach which are Define (D), Measure (M), Analyse (A), Improve (I) and Control (C) (Figure 3.4), pronounced Dee-May-Ick.

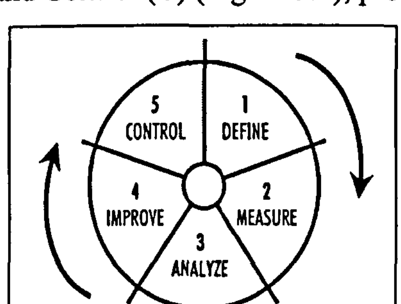


Figure 3.4: Six Sigma DMAIC continuous improvement methodology

It is used for improving a current process or existing product/service performance which does not meet customer expectations or perform to a satisfactory level. DMAIC is a structured, disciplined, rigorous approach to process improvement, where each phase is linked logically to the previous phase as well as to the next. Each phase has a specific purpose and set of desired outcomes that signal the completion of one phase and the beginning of another. Each phase is designed to help the team focus on those critical variables that will have the most impact on achieving their goals. The reason to follow this rigorous methodology is to achieve the stretch goal of Six Sigma or 3.4 DPMO (Stamatis, 2004). It is a method and roadmap to approach Six Sigma for solving a problem with an unknown solution and improving defects. The DMAIC methodology process (see Table 3.2) is the key to achieving the breakthrough improvement in performance. It is a non-linear process; if any step yields new information, earlier steps in the process must be re-evaluated. Each Six Sigma project must use the DMAIC structure to guide the organisation through the defined steps as follows (Chollar, 2005; Eckes, 2001a):

- *Define:* This phase involves the definition of the project/assignment, using process map, application area, desired improvement, likely benefits, etc.. It defines the problem, opportunities, project goals and customer (internal and external) deliverables. The importance lies in having the chance of a highly successful delivery of better quality and saving costs in totality.
- *Measure:* Analysis of process to determine its present state and future, as obtained. Data collection is the main emphasis of this phase. Measure the process to determine current performance and establish a baseline.
- *Analyse:* Data analysis for identification of parts of the process which affect quality of the problem. It analyses and determines the root cause(s) of the defects.
- *Improve:* Adds to the process to find a permanent solution to the problem. This may involve better forecasting, better scheduling, better procedures or equipment. It improves the process by eliminating defects.
- *Control:* Process of closing the problem by putting in right procedures and management statistics. It controls future process performance.

Table 3.2: Six Sigma DMAIC Methodology

Step	Title	Key Processes Description
1	Define	▪ Define requirements and expectations of customer. ▪ Define project boundaries. ▪ Define process by mapping business flow.
2	Measure	▪ Measure process to satisfy customer's needs. ▪ Develop data collection plan. ▪ Collect and compare data to determine issues and shortfalls.
3.	Analyse	▪ Analyze causes of defects and sources of variation. ▪ Determine variations in process. ▪ Prioritize opportunities for future improvement.
4	Improve	▪ Improve process to eliminate variations. ▪ Develop creative alternatives and implement enhanced plan.
5	Control	▪ Control process variations to meet customer requirements. ▪ Develop strategy to monitor and control improved process. ▪ Implement improvements of systems and structures.

Source: McClusky, (2000)

According to Pande and Holpp (2002b), the following are the main advantages and benefits of implementation of DMAIC principles to improving a current process or improving existing product/service performance which does not meet customer expectation:

- Uses facts to measure a problem and not just make assumptions.
- Focuses on customer for end results.
- Verifies root cause of the problem with facts and data.
- Comes up with major breakthrough solutions.
- Manages risk by testing and perfecting solutions.
- Measures results to verify real impacts.
- Sustains changes made.

3.4 Reasons for/ Benefits of Six Sigma Implementation

Six Sigma has become one of the famous quality improvement initiatives and important in many organisations because they believe that this way of working reduces their waste and uses advanced tools and techniques of statistical analysis (Banuelas and Antony, 2002). Successful implementation of Six Sigma leads to a number of significant benefits. The following list presents the most common reasons for/ benefits of implementing Six Sigma derived from extensive reviews of literature (Hendericks and Kelbaugh, 1998; Murphy, 1998; McClung, 1999; Harry and

Schroeder, 2000; Henderson and Evans, 2000; Pande *et al.*, 2000, 2001; Keller, 2001; Attenello and Uzzi, 2002; Brue, 2003a; Weiner, 2004):

- Improves organisation efficiency.
- Reduces and minimises capital spending (cost reduction, error and waste/non-value added activities reduction, reduces non-value added operations, costs of operations, variations and number of defects/errors).
- Achieves, increases, improves and provides high levels of customer satisfaction by better understanding of customer needs, requirements and expectations and gaining customer loyalty and identifying customers critical-to-quality (CTQ) and in addition, it provides critical process inputs to respond to changing customer requirements.
- Optimises the use of resources.
- Provides more reliable and improved speed and accuracy of products and services.
- Generates robust, flexible business process and bottom line results.
- Improves human performance across the organisation (improving effectiveness of employees in their performance, employee satisfaction and better employee efficiency and setting a performance goal for everyone).
- Improves processes to do things better, faster and at lower cost.
- Provides and achieves continuous improvement in productivity and ensures continuity and sustainability.
- Changes organisation culture (embracing a culture change of relentless continual improvement and positive changes to corporate culture).
- Executes strategic change, promotes learning and plans strategically with new business strategy.
- Empowers, manages and encourages effective management decisions role based on fact.
- Produces product/service on time and within budget (processes' cycle time reduction).
- Improves and increases financial performance, earnings and profitability of business.
- Improves on-time delivery and quality performance.
- Maintains, improves and increases market share (increasing competitive advantage).

- Generates sustained success, develops a strong process orientation, defines full layout of processes, improves process flow, improves production yields and defines the problem area.
- Emphasises on measurement and measures pre-defined goals.
- Ensures efficient and reliable internal operations, leading to greater market share and satisfied shareholders.
- Increases and enhances learning, motivation to excel.
- Provides a common approach to process improvement throughout the organisation.
- Focuses on tangible and measurable results and accelerated improved business results.
- Improves and creates cross-functional teamwork across the entire organisation.
- Improves quality of product or service as perceived by the customer (internal and external).
- Provides common language throughout the organisation.
- Translates business strategy into action and aligned to critical improvement efforts.
- Improves and develops knowledge and skills of individual, problem solving skills, transferable leadership skills and ability to use a wide range of tools and techniques at all levels of the organisation.

Smaller organisations have had similar financial success to larger organisations but on a smaller scale (Harry, 1998; Brue, 2003b; Gnibus and Krull, 2003). Another advantage of this strategy is that it can be applied to any type of organisation, manufacturing or services organisation. It is focused on preventing errors by using the organisation's resources more effectively and efficiently. This maximises profits for the organisation and creates exceptional value for its customers.

From a financial perspective, there have been numerous reports about how Six Sigma helps to obtain substantial financial profits in many leading organisations such as GE, Motorola, AlliedSignal and others that have applied Six Sigma and have saved billions of dollars from operation costs and cultural change as a result of implementing of Six Sigma and have derived many benefits (Pande *et al.*, 2000). For example, from 1987 to 1997, Motorola achieved a five-fold growth in sales with yearly profits climbing nearly 20 per cent, cumulative savings at US$14 billion and stock price gains compounded to an annual rate of 21.3%. Motorola was also cited as the first winner of America's Malcolm Baldrige National Quality Award (MBNQA) in 1988. Between 1988 and 1991, Motorola reduced its internal defects from 10,000 DPMO to 20 and its quality level as indicated by customer feedback reports improved by 20 times in two years (Snee and Hoerl, 2003). Motorola had spent US$170 million on employees' education and training and as a result it saved US$2.2 billions in reducing cost of poor quality (such as reduced scrap, rework, warranty costs, etc.). It took a full five years to see significant results. Motorola attributed US$15 billion in savings from 1987 to 1998 to Six Sigma (Paul, 1999).

When GE decided to go with Six Sigma, it set stretch goals and in 1997 alone invested US$380 million, mostly for training. However, the payback in the same year was about US$700 million in documented benefits from increased productivity (Paul, 1999). In 1997, the GE organisation raised its organisation-wide savings estimates twice: from between US$400 million and US$500 million up to between US$600 million and US$650 million and finally up to US$700 million (Pande *et al.*, 2000). In 1998, GE expected to see benefits of US$1.2 billion. In 2002, GE spent US$600 million and saved over US$2 billion (Watson, 2003). AlliedSignal has shown an incredible upturn since it introduced Six Sigma, it started its Six Sigma quality programme in the early 1990s and saved more than US$600 million a year by 1999 (Pande *et al.*, 2000). Table 3.2 shows the key benefits gained by Motorola, GE and AlliedSignal from the implementation of Six Sigma.

Table 3.3: Key benefits gained by Motorola, GE and AlliedSignal from implementation of Six Sigma

Organisation	Benefits Gained
Motorola (1987-1997)	▪ Five-fold growth in sales, profits climbing nearly 20% per year. ▪ Cumulative saving based on Six Sigma efforts pegged at US$14 billion. ▪ Motorola stock price gains compounded to annual rate of 21.3% (Pande *et al.*, 2000).
General Electric (1995-1999)	▪ Net savings of US$1,500,000,000 in 1999 from Six Sigma alone. ▪ Expected eventual annual savings in excess of US$6,000,000,000. ▪ Average share price increase of 40%each year (Tennant, 2001).
AlliedSignal (1990-1999)	▪ By 1999, saving more than US$600 billion a year. ▪ Time for designing new products such as aircraft engines reduced from design to certification from 42 to 33 months. ▪ In 1998, productivity increased by 6% and with record profit margins of 13%. ▪ Since Six Sigma effort began through fiscal year 1998, firm's market value climbed to compound 27% per year (Parade *et al.*, 2000).

3.5 Potential Challenges in Six Sigma Implementation

Investigation of the challenges during the implementation process is very important. Several authors identified these challenges in some cases because Six Sigma is being implemented in an inappropriate context. The real challenge with Six Sigma is getting to the point where one can meaningfully measure a business's current performance against dynamic customer requirements while developing the internal organisational abilities to respond to changing marketplace conditions. Doing this well means aligning organisational components inside the organisation (leadership, strategy, people and technology) to give Six Sigma efforts the momentum and staying power needed to succeed (Blakeslee, 1999b).

According to Eckes (2001a), some of the challenges awaiting an organisation in implementing Six Sigma are:

- Failure to achieve quick success, due to failure of the first wave of projects to bear fruit. True commitment to Six Sigma will not occur until there are first successes within the organisation.
- Competing distractions; that is the distractions caused by implementing other quality and process improvement initiatives in conjunction with Six Sigma.
- Setting unrealistic time frames for fully achieving Six Sigma cultural transformation.
- Ignoring previous quality efforts; this will cause resistance to Six Sigma from those involved in quality.
- Poor Six Sigma cultural planning and follow-through, as most of the planning is done around the technical aspects of the implementation.
- Delegating cultural development to others or thinking a one-time intervention will result in the desired outcome.
- Not having cultural goals or objectives.
- Not allowing for unexpected interruptions.
- Failing to understand necessary resource allocation.

Some authors highlight specific challenges of Six Sigma implementation (Harry, 2000b; Gnibus, 2000; Basu and Wright, 2004; McAdam and Lafferty, 2004). Some of the potential challenges in implementing the Six Sigma methodology include the following:

- Fear of change. This could be the most important obstacle to improvement, by organisational resistance to change. It could be difficult to change employees' attitudes and the work methods which they have been used for performing their tasks, particularly if the employees are not certified/qualified or trained in new working methods and techniques.
- Lack of confidence in Six Sigma. The organisation's management and employees could lack confidence that Six Sigma could solve and improve the organisation's problems. This could be due to other organisations' failure with Six Sigma programmes.
- Top management not committed to quality improvement. Lack of this commitment may result in employees seeing Six Sigma and its improvement initiative as something temporary that will fizzle out with time and that the top management is not serious about it.
- Lack of support to team members. The improvement of team members may lack appropriate support from the top management in carrying out their tasks. This would result in employees' lacking the necessary supporting tools and equipment for improvement and the confidence that their efforts for improvement would be recognised and rewarded.
- Lack of team-working. Team members do not know where to start. The areas for improvement sometimes might be unclear for team members or inappropriately identified, or sometimes the team members do not know which problem to start with, due to the complexity of the problems or the areas needing to be improved.
- High costs of improvements. The costs for some areas that need to be improved could be very high and require potential resources; this would limit top management's support for improving those areas, which stay unimproved.
- Lack of data collection and analysis. The source of the data and actual data are not readily available for analysis and are more difficult to collect. The fundamental problem is with the accuracy and completeness of the data.
- The measurement of customer satisfaction is more difficult due to the human behavioural interaction associated with production, the product or delivery of service. Organisations struggle to identify processes which can be measured in terms of DPMO.

- Too much focus on BB and GB training without identifying projects for improvement sufficient to training.
- Lack of understanding of the strategic intent of Six Sigma.
- Too many books and too much talk about Six Sigma.
- Lack of innovation in problem solving, no real breakthroughs.
- Cost of Six Sigma training and consulting.
- Too much focus on projects instead of processes.
- Fragmentation of various corporate initiatives.
- Lack of resources.
- Lack of empowerment, not empowering employees where appropriate, before adopting Six Sigma.
- Employee mindset and detection-based mentality.
- Lack of knowledge and understanding.
- Poor application of tools and techniques.
- Measurement problems.
- Lack of communication.
- Poor project management.

3.6 Reasons for Six Sigma Implementation Project Failure

According to Byrne (2003), there are reasons for the failure of a few Six Sigma projects, such as one of the biggest, which is that organisations do not always provide these initiatives with the strong and visionary leadership they require to truly take hold in an organisation and fundamentally change how people do their everyday jobs. Six Sigma is a highly statistically intense approach to quality process improvement requiring not only deep technical knowledge to implement but also strong organisational resolve to launch and sustain. No individual, not even a powerful CEO, can successfully launch and sustain a Six Sigma initiative alone. It requires a significant amount of teamwork among many people at all levels in the organisation, in addition to the CEO and the rest of the top management, in order to complete Six Sigma projects and dramatically change how business processes operate.

A failure of some Six Sigma projects occurs when top management business leader, mandate that Six Sigma methods be quickly implemented and that results from the projects quickly follow. This can be unrealistic. Six Sigma represents an entirely new way of working and it relies on the collection and analysis of data and the use of numerous statistical tools for correcting defects. To be successful, it must be supported with a strong infrastructure (training, communications, carefully considered metrics, specific rewards/incentives, etc.) from the moment it is launched. Even then, there typically is a steep learning curve involved in getting the effort up and running. People need time to become conversant with the methodology, master the statistical intricacies of Six Sigma work techniques and become comfortable with using a 'data-driven' approach to get their jobs done. Too many programmes die when the project team faces technical issues they do not fully understand. Or the project team thinks it does understand the problem but its approach fails to deliver the expected results (Goldstein, 2001). According to Eckes (2000), most of the projects fail due to:

- Poor management skills.
- Not setting clear agendas.
- Not setting and keeping ground rules.
- Not determining the roles and responsibilities.
- Undesired facilitative behaviours.

In the same context, Bhote (2002) pointed out that one reason for Six Sigma failure is that organisations lacking in the kind of statistical expertise possessed by Six Sigma BBs failed to understand the fundamental processes that must be mastered for Six Sigma to succeed. Second, a number of opportunistic consulting organisations have quite literally misled a number of their clients and implemented Six Sigma programmes that were either incomplete or inadequate to the task for which they were intended. Six Sigma projects can also fail if BBs receive neither the coaching and training nor top-leadership mentoring they need to succeed in their jobs.

According to Gupta (2004), there are many factors which can be considered as the main ones for failure in implementing the Six Sigma approach, such as the following:

1. Leadership failures

- Not taking enough time to understand and see the benefits of Six Sigma.
- Lack of passionate commitment to achieving dramatic results.
- Setting low or no expectations for achievement with Six Sigma.
- Not treating Six Sigma as a leadership initiative and giving it the highest priority.
- Lack of organisational alignment to involve all functions and to change the way of doing things.
- Lack of identification of opportunities for improvement relating to profitability before launching Six Sigma.
- Not integrating compensation structure with actual savings resulting from Six Sigma mindset.
- Lack of employee recognition and participation.
- Not driving out fear.
- Not changing the product development methodology, with design and manufacturing blaming each other.
- Not making time for Six Sigma projects, somehow perceived as extra work that must not be important.
- Lack of involvement by president or CEO, total delegation of Six Sigma to the corporate champion.
- Not giving opportunity for middle managers and employees to express their views regarding the organisational change.
- Not having the vision for the future and leadership styles (Gupta, 2004).

2. Black Belt failures

- Limited understanding of leadership and interpersonal aspects of BB role.
- Too much emphasis on statistics and complicated tools.
- Lack of facilitation skills, causing poor teamwork.
- Not clearly defining problem in enough detail.
- Lack of innovation through collaboration and systems thinking.
- Too many BBs, disproportionate to identified opportunities.
- Fabricated savings from projects through creative maths (Gupta, 2004).

3. Green Belt failures

- Not empowered to produce great results.
- Low expectations of GBs.
- Lack of involvement of GBs.
- Rivalry among GBs and BBs due to poorly defined roles.
- Assignment of GBs to supporting roles instead of leading ones.
- Perceived lack of respect for GBs compared to BBs.
- Lack of recognition of GBs (Gupta, 2004).

4. Employee failures

- Failure to enlist employees enough in problem-solving activities.
- Lack of an established process for encouraging employees' intellectual involvement.
- Insufficient training given to employees in problem solving.
- Lack of time given to employees for their active involvement.
- Productivity emphasised over creativity and quality.
- Lack of empowerment to identify, prioritise and improve processes (Gupta, 2004).

5. Consultant failures

- Understanding Six Sigma as a collection of advanced and complicated statistical tools.
- Focusing on 3.4 DPMO and thinking one has to produce millions of parts to measure sigma level.
- Treating Six Sigma like another problem.
- Not emphasising the strategic component of Six Sigma that requires the CEO's passionate commitment.
- Focusing on training lots of people before identifying the opportunity for profits (Gupta, 2004).

All of these pitfalls can be effectively addressed through careful planning and introduction of Six Sigma implementation. The chances of success can also improve once an organisation's employees see Six Sigma projects begin to generate financial results; they often become strong zealt of the methodology at that point and help drive fundamental culture change to support a 'Six Sigma way of working.' Still, getting to this point requires intentional, highly focused efforts by an organisation's top leaders to overcome both organisational inertia and employee indifference, especially at the very beginning of an initiative.

3.7 Chapter Summary

This chapter has presented the Six Sigma implementation issues through a comprehensive review of the relevant literature. It has explained the Six Sigma organisational infrastructure (roles), consisting of key players given special titles of martial arts colour belts based on their skills as Champion, MBB, BB, GB and YB, also known as team member. Then, it has described the Six Sigma implementation methodologies used in managing Six Sigma projects for both process improvement and new development projects that included the Six Sigma DMAIC continuous improvement methodology and the DMADV design/redesign model. In addition, it has given the reasons for/ benefits of implementing Six Sigma projects and potential challenges in Six Sigma implementation. Finally, reasons for failure of Six Sigma implementation projects were discussed.

CHAPTER 4

CRITICAL SUCCESS FACTORS FOR EFFECTIVE SIX SIGMA IMPLEMENTATION

CHAPTER 4

LITERATURE REVIEW III - CRITICAL SUCCESS FACTORS FOR EFFECTIVE SIX SIGMA IMPLEMENTATION

4.1 Introduction

This chapter presents the third part of the literature review and deals with the critical success factors (CSFs) that affect Six Sigma implementation and drive the success of Six Sigma projects. The chapter starts with what CSFs are. Then it provides and discusses the previous studies of CSFs for Six Sigma implementation. Next, it reviews in detail the CSFs for effective Six Sigma implementation and best practices. Finally, it concludes with a chapter summary. Figure 4.1 shows the structure of the chapter.

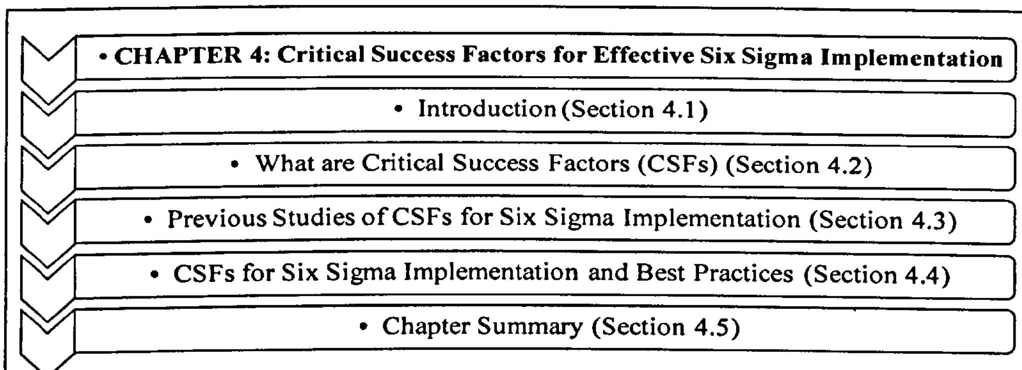


Figure 4.1: Structure of Chapter 4

4.2 What Are Critical Success Factors (CSFs)?

The term CSF describes the underlying or guiding principles of an effort that must be followed to ensure that it is successful. They are those factors that are essential to the success of the implementation of any quality improvement initiative. In addition, Rockart (1979) defined CSFs as "those factors that are vital and critical to the success of any organisation, in the sense that if objectives associated with the factors are not achieved, the organisation will fail, while if they are satisfactory, they will ensure successful competitive performance for the organisation". In the Six Sigma context, CSFs are the factors that have to be achieved in order to stand any chance of success and are those ingredients necessary for the successful and effective implementation of any Six Sigma project. In addition, they can be viewed as those activities and practices that should be addressed in order to ensure successful and effective implementation. These would need either to be nurtured if they already exist or developed if they are not yet in place. The identification of such factors will encourage their consideration when organisations are developing an appropriate implementation plan.

The CSFs can be seen as points, areas or goals that have to be given extensive attention and support by the top management and represent those managerial areas that must be given special and continual attention to bring about high performance. Further, awareness and understanding of such factors will also help to avoid failures of Six Sigma projects in future implementation. Moreover, organisations must take account of the CSFs in order to make the most of the Six Sigma-related advantages. In the context of Six Sigma project implementation, CSFs represent the essential ingredients without which a project stands little chance of success.

4.3 Previous Studies of CSFs for Six Sigma Implementation

Based on a comprehensive review of Six Sigma literature in the implementation area, the CSFs of Six Sigma are considered as one of the critical objectives and the theoretical framework of this research. The review of the academic and practitioner literature regarding Six Sigma implementation shows limited work to reveal the CSFs for implementing Six Sigma. To date, many practitioners and researchers have identified various key factors for the successful implementation of Six Sigma and the researcher found 27 relevant articles/studies on CSFs, as set out in Table 4.1.

Table 4.1: Literature focusing on CSFs of Six Sigma implementation (Authors in alphabetical order)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
1	Anbari, F. T. and Kwak, Y. H.	2004	Success factors in managing Six Sigma projects	*Project Management Institute Research Conference.* London, UK, 11-14 July	*Literature review,* Discussions with Six Sigma leaders at several organisations.	1. Management commitment, organisational involvement and project governance; 2. Project selection, planning and implementation methodology; 3. Six Sigma project management and control; 4. Encouraging and accepting cultural change; and 5. Continuous education and training.
2	Antony, J.	2004a	Six Sigma in the UK service organisations: results from a pilot survey	*Managerial Auditing Journal,* Vol. 19, No. 8, pp. 1006-1013	*Comparative study and Pilot survey*	1. Integrating Six Sigma with business strategy; 2. Customer focus 3. Project management skills; 4. Executive leadership and senior management commitment; 5. Organisational infrastructure; 6. Project selection and prioritisation; 7. Management of cultural change; 8. Integration of Six Sigma with financial accountability; 9. Understanding DMAIC methodology; 10. Training and education; 11. Project tracking and reviews; 12. Incentive programme; and 13. Organisation-wide commitment.
3	Antony, J.	2006	Six Sigma for service processes	*Business Process Management Journal,* Vol. 12, No. 2, pp. 234-248	*Descriptive study*	1. Strong leadership and management commitment; 2. Organisational culture change; 3. Aligning Six Sigma projects to corporate business objectives; 4. Selection of team members and teamwork; 5. Six Sigma training; 6. Understanding DMAIC methodology, tools, techniques and key metrics; 7. Selection of projects and project management skills; 8. Integrating Six Sigma to customers; and 9. Accountability (tying results in financial terms to the bottom-line).

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
4	Antony, J. and Banuelas, R.	2002	Key ingredients for the effective implementation of Six Sigma programme	*Measuring Business Excellence,* Vol. 6, No. 4, pp. 20-27	*Pilot study*	1. Top Management involvement and commitment; 2. Cultural change; 3. Organisation infrastructure; 4. Training; 5. Project management skills; 6. Project prioritisation and selection, reviews and tracking; 7. Understanding Six Sigma methodology, tools and techniques; 8. Integrating Six Sigma with business strategy; 9. Integrating Six Sigma with customer; 10. Integrating Six Sigma with human resources; and 11. Integrating Six Sigma with suppliers.
5	Antony, J. and Fergusson, C.	2004	Six Sigma in the software industry: results from a pilot study	*Managerial Auditing Journal,* Vol. 19, No. 8, pp. 1025-1032	*Comparative study*	1. Commitment of top management leadership; 2. Supporting organisational infrastructure; 3. Cultural change; 4. Six Sigma training; 5. Integrating Six Sigma with business strategy; 6. Accountability; 7. Customers involvement; 8. Understanding Six Sigma methodology; 9. Project management; and 1. Project prioritisation and selection.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
6	Antony, J., Antony, F. J., Kumar, M. and Cho, B. R.	2007	Six Sigma in service organisations - benefits, challenges and difficulties, common myths, empirical observations and success factors	*International Journal of Quality and Reliability Management*, Vol. 24, No. 3, pp. 294-311	*Literature review*	1. Integrating Six Sigma with business strategy; 2. Customer focus; 3. Project management skills; 4. Management commitment and involvement; 5. Organisational infrastructure; 6. Understanding Six Sigma methodology; 7. Project selection and prioritisation; 8. Integration of Six Sigma with financial accountability; 9. Management of cultural change; 10. Training and education; 11. Project tracking and reviews; 12. Incentive programme; and 13. Organisation-wide commitment.
7	Antony, J., Kumar, M. and Madu, C. N.	2005	Six Sigma in small and medium-sized UK manufacturing enterprises, some empirical observations	*International Journal of Quality and Reliability Management*, Vol. 22, No. 8, pp. 860-874	*Literature review*	1. Management involvement and participation; 2. Organisational infrastructure; 3. Cultural change; 4. Training; 5. Integrating Six Sigma with customers; 6. Integrating Six Sigma with business strategy; 7. Integrating Six Sigma with employees; 8. Integrating Six Sigma with suppliers; 9. Understanding of Six Sigma methodology; 10. Project management skills; and 11. Project prioritisation and selection.
8	Blakeslee, J. A.	1999a	Achieving quantum leaps in quality and competitiveness: Implementing the Six Sigma solution in your organisation	*ASQ Annual Quality Congress Proceedings*, Milwaukee, pp. 486-496	*Descriptive study*	1. Committed leadership; 2. Integrated with top level strategy; 3. Customer and market intelligence network; 4. Business process framework; 5. Incentives and accountability; 6. Full-time Six Sigma team leaders; and 7. Projects produce real savings or revenues.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
9	Blakeslee, J. A.	1999b	Implementing the Six Sigma solution - how to achieve quantum leaps in quality and competitiveness	*Quality Progress*, Vol. 32, No. 7, pp. 77-85	*Descriptive study*	1. Committed leadership with edge; 2. Integrated with existing initiatives, business strategy, and performance measures; 3. Disciplined customer and market intelligence network; 4. Business and thinking process framework; 5. Incentives and accountability; 6. Full-time and trained Six Sigma team leaders; 7. Projects produce real savings or revenues; and 8. Continuous reinforcement and reward of leaders.
10	Byrne, G.	2003	Ensuring optimal success with Six Sigma implementations	*Journal of Organisational Excellence*, Vol. 22, No. 2, pp. 43-50	*Descriptive study*	1. Strong hands-on top leadership of initiatives; 2. Ability to cascade Six Sigma leadership responsibilities to leaders at all levels in organisation; 3. Ability of organisation's top leadership and senior Six Sigma champion to elicit commitment of business process owners to Six Sigma principles and practices; 4. Careful selection of BBs to spearhead Six Sigma projects; and 5. Appropriate and customised training of BBs to help them fulfil their Six Sigma leadership roles and project goals.
11	Chakrabarty, A. and Tan, C. K.	2007	The current state of Six Sigma application in services	*Managing Service Quality*, Vol. 17, No. 2, pp. 194-208	*Literature review*	1. Top management commitment; 2. Education and training; 3. Cultural change; 4. Customer focus; 5. Clear performance metrics; 6. Attaching success to financial benefits; and 7. Organisational understanding of work processes.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
12	Coronado, R. B. and Antony, J.	2002	Critical success factors for the successful implementation of Six Sigma projects in organisations	*The TQM Magazine* Vol. 14, No 2, pp. 92-99	*Literature review* CSFs derived from thorough analysis of various journal papers, books and case studies.	1. Management involvement and commitment; 2. Cultural change; 3. Communication; 4. Organisation infrastructure; 5. Training; 6. Integrating Six Sigma with business strategy; 7. Integrating Six Sigma with customer; 8. Integrating Six Sigma with human resources; 9. Integrating Six Sigma with suppliers; 10. Understanding tools and techniques within Six Sigma; 11. Project management skills; and 12. Project prioritisation and selection.
13	George, M.	2002	Lean Six Sigma: combining Six Sigma quality with Lean speed	*New York, McGraw-Hill*	*Book*	1. Customer focus for project choice; 2. Project feasibility of projects in limited timeframe; 3. Evaluation of resp. of profitability; 4. Consequent agreement on objectives and controlling of results; 5. Focus on essential business processes; 6. Application of approved toolset; 7. Consequent enabling of employees and provision of resources
14	Goldstein, M.	2001	Six Sigma programme success factors	*ASQ Six Sigma Forum Magazine,* Vol. 1, No. 1, pp. 36-45	*Literature review*	1. Deployment plan; 2. Active participation of the senior executives; 3. Project reviews; 4. Technical support (MBBs); 5. Full-time vs. part-time resources; 6. Training; 7. Communications; 8. Project selection; 9. Project tracking; 10. Incentive programme; 11. Safe environment; 12. Supplier plan; and 13. Customer 'WOWS'.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
15	Henderson, K. M. and Evans, J. R.	2000	Successful implementation of Six Sigma: benchmarking General Electric organisation	*Benchmarking: An International Journal*, Vol. 7, No. 4, pp. 260-281	*Literature review and case study:* General Electric (GE) Organisation	1. Upper management support/involvement; 2. Organisational infrastructure; 3. Training; 4. Statistical tools; 5. Link to human resources-based actions (promotions, bonuses, etc.); 6. Communication to employees; 7. Measurement systems; and 8. Information technology infrastructure.
16	Hendry, L.	2005	Exploring the Six Sigma phenomenon using multiple case study evidence	Lancaster University Management Working Paper	*Empirical study,* Evidence from 11 case study companies.	1. Management involvement; 2. Effectiveness of Six Sigma training programme; 3. Six Sigma organisation (Project champion, Master Black Belt (MBB), Black Belt (BB), etc.); 4. Motivation programme; 5. Impact of assigning Black Belt (BB) to either full-time or part-time post; 6. Type of reporting structure; and 7. Nature of technical support available.
17	Hoerl, R.	1998b	The fundamentals of Six Sigma	*Quality Progress*, Vol. 31, No. 6, pp. 36-38	*Literature review*	1. Continued top management support and enthusiasm; 2. Emphasis on quantitative and disciplined approach to process improvement; 3. Value placed on understanding and satisfying customer needs; 4. Big dollar impact; and 5. Manner in which it combines right projects with right people and tools.
18	Johnson, A. and Swisher, B.	2003	How Six Sigma Improves R&D	*Research Technology Management*, Vol. 46, No. 2, pp. 12-15	*Literature review*	1. Sustained and visible management commitment; 2. Continuing Education and training of managers and participants; 3. Set clear expectations and select project leaders carefully for leadership skills; 4. Pick and select strategically important projects.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
19	Kwak, Y. H. and Anbari, F. T.	2006	Benefits, challenges and future of Six Sigma approach	*Technovation*, pp. 1-8	*Literature review*	1. Management involvement and organisational commitment; 2. Project selection, management and control skills; 3. Encouraging and accepting cultural change; and 4. Continuous education and training.
20	Lee, K.	2002	Critical success factors of Six Sigma implementation and the impact on operations performance	PhD. Dissertation, Cleveland State University	*Exploratory study*	1. Previous quality programme adoption; 2. Top management leadership; 3. Managerial processes; 4. BB's background; 5. Full-time and part-time black belts; 6. Six Sigma training programmes; and 7. Statistical and analytical tool usage.
21	McAdam, R. and Evans, A.	2004b	The organisational contextual factors affecting the implementation of Six Sigma in a high technology mass-manufacturing environment	*International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 29-43	*Exploratory study*	1. Management; 2. Communication; 3. Project management; 4. Six Sigma training; and 5. Rewards and recognition.
22	Pande, P. S., Neuman, R. P. and Cavanagh, R. R.	2000	The Six Sigma Way: How GE, Motorola, and other top companies are honing their performance	McGraw-Hill, New York	*Book*	1. Customer focus for project choice; 2. Project feasibility of the projects in a limited timeframe; 3. Evaluation of profitability; 4. Consequent agreement on objectives and controlling of results; 5. Focus on essential business processes; 6. Application of approved toolset; 7. Consequent enabling of employees and provision of resources.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article/Book Title	Journal/Conference/ Publisher	Study Type	CSFs of Six Sigma Implementation
23	Sandholm, L. and Sorqvist, L.	2002	12 Requirements for Six Sigma success	*ASQ Six Sigma Forum Magazine,* Vol. 2, No. 1, pp. 17-22	*Literature review*	1. Management commitment and visible support; 2. Treatment of Six Sigma as holistic concept; 3. Investment of adequate resources; 4. Focus on results; 5. Customer orientation; 6. Focus on training and its content; 7. Adaptation to organisation's situation and needs; 8. Prioritisation and selection of projects; 9. Development of uniform language and terminology; 10. Development of strategy to introduce Six Sigma; 11. Follow-up and communication of success stories; 12. Responsiveness to external influences.
24	Shahin, A.	2007	Analysis of Six Sigma Critical Success Factors in Iranian Car Making Companies	*Proceedings, Middle East Quality Association (MEQA) 1st International Annual Congress,* March 25-27, Dubai	*Exploratory study*	1. Management commitment and involvement; 2. Cultural changes; 3. Organisational infrastructures; 4. Training; 5. Project manager skills; 6. Selection, evaluation and prioritisation of Six Sigma projects; 7. Understanding methodology and techniques of Six Sigma; 8. Linking Six Sigma to business strategy; 9. Linking Six Sigma to customers; and 10. Linking Six Sigma to employees.
25	Snee, D. R.	1999	Why should statisticians pay attention to Six Sigma? An examination for their role in the Six Sigma methodology	*Quality Progress,* Vol. 32, No. 9, pp. 100-103	*Literature review*	1. Management leadership; 2. Customers and processes are focused; 3. Bottom-line results; 4. Rapid project completion; 5. Clear defined success; 6. Infrastructure established; 7. Statistical approach; and 8. Disciplined approach.

(continued)

Table 4.1: (continued)

No.	Author(s)	Year	Article Title	Journal/Conference Publisher	Study Type	CSFs of Six Sigma Implementation
26	Starbid, D.	2002	Business Excellence: Six Sigma as a Management System	*Proceedings, ASQ's 56th Annual Quality Congress* pp. 47-55	*Case study*	1. Start process management: identify core processes, customer needs and measures; 2. Drive performance through reporting: Leaders must maintain and report opportunity lists, status of active projects/resources, and results from finished projects. 3. Integrate championing of active projects: Select and charter projects and require updates during existing staff meetings.
27	Wyper, B. and Harrison, A.	2000	Deployment of Six Sigma methodology in human resource function: a case study	*Total Quality Management,* Vol. 11, No. 4, pp. S720-S728	*Case study*	1. Management involvement and commitment; 2. Cultural change; 3. Organisation infrastructure; 4. Training; 5. Project management skills; 6. Project prioritisation and selection, reviews and tracking; 7. Understanding the Six Sigma methodology, tools and techniques; 8. Integrating Six Sigma with business strategy; 9. Integrating Six Sigma with customer; 10. Integrating Six Sigma with human resources; and 11. Integrating Six Sigma with suppliers.

Table 4.2: Emphasis of 27 authors on various CSFs in Six Sigma implementation (descending)

No.	CSFs of Six Sigma Implementation	Key Authors																											Weighting (Total 27)
		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	
1	Continued and strong top management commitment, support and involvement.	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*		*	*	*		*	24
2	Continuous effective training and education system	*	*	*	*	*	*	*			*	*	*		*	*	*		*	*	*	*		*	*			*	20
3	Project prioritisation, selection, tracking, reviews and reports	*	*	*	*	*	*	*					*	*	*		*		*	*			*	*	*		*	*	18
4	Integrating Six Sigma with customer expectations and needs (Customer focus)		*	*	*	*	*	*				*	*	*	*			*					*	*	*	*	*	*	17
5	Understanding the effective use of Six Sigma methodologies tools and techniques		*	*	*	*	*	*					*	*		*	*				*		*		*	*		*	15
6	Forming suitable and supporting organisational infrastructure		*	*	*	*	*	*					*			*	*		*						*	*	*	*	14
7	Integrating Six Sigma with corporate business strategy		*	*	*	*	*	*	*	*			*	*									*	*	*			*	14
8	Encouraging organisational culture change	*	*	*	*	*	*	*				*	*							*					*			*	12
9	Project management skills		*	*	*	*	*	*					*						*		*				*			*	11
10	Integration of Six Sigma with financial goals and accountability		*	*		*	*		*	*		*		*				*					*						10
11	Selection of right project members and teamwork (full-time and part-time)			*					*	*	*							*			*						*		7
12	Business process framework								*	*		*		*							*		*			*			7
13	Integrating Six Sigma with human resources				*								*	*		*							*					*	6
14	Effective communication and follow-up of success stories and safe environment												*		*	*						*		*					5
15	Incentives programme								*	*					*			*						*					5
16	Integrating Six Sigma with supplier				*			*					*		*													*	5
17	Integrating Six Sigma with employees (involvement and empowerment)	*												*									*		*				4
18	Continuous reinforcement, rewards and recognition									*							*					*							3
19	Organisation-wide commitment		*				*				*																		3
20	Clear performance metrics and measurement system											*												*			*		3
21	Disciplined customer and market intelligence network								*	*																			2
22	Integrating Six Sigma with existing initiatives		*							*																			2
23	Integrating Six Sigma with information technology (IT)															*													1

Key Authors

[1] Anbari, F. T. and Kwak, Y. H. (2004)	[8] Blakeslee, J. A. (1999a)	[15] Henderson, K. M. and Evans, J. R. (2000)	[22] Pande *et al.* (2000)
[2] Antony, J. (2004)	[9] Blakeslee, J. A. (1999b)	[16] Hendry, L. (2005)	[23] Sandholm, L. and Sorqvist, L. (2002)
[3] Antony, J. (2006)	[10] Byrne, G. (2003)	[17] Hoerl, R. (1998)	[24] Shahin, A. (2007)
[4] Antony, J. and Banuelas, R. (2002)	[11] Chakrabarty, A. and Tan, C. K. (2007)	[18] Johnson, A. and Swisher, B. (2003)	[25] Snee, D. R. (1999)
[5] Antony, J. and Fergusson, C. (2004)	[12] Coronado, R. B. and Antony, J. (2002)	[19] Kwak, Y .H. and Anbari, F. T. (2006)	[26] Starbid, D. (2002)
[6] Antony *et al.* (2007)	[13] George, M. (2002)	[20] Lee, K. (2002)	[27] Wyper, B. and Harrison, A. (2000)
[7] Antony *et al.* (2005)	[14] Goldstein, M. (2001)	[21] McAdam, R. and Evans, A. (2004)	

4.4 CSFs for Effective Six Sigma Implementation and Best Practices

A critical review of literature and case studies of Six Sigma leading organisations helps to identify some best practices related to the CSFs of Six Sigma implementation. This section presents the key CSFs that influence the effective implementation of the Six Sigma programme in different organisations based on the review of Six Sigma implementation literature and best practice.

4.4.1 Top Management Commitment

All the literature reviewed agrees that continued and strong top management involvement, highly visible support and organisational commitment are a must for successful Six Sigma implementation (Henderson and Evans, 2000; Coronado and Antony, 2002). It appears clearly in the Six Sigma success stories for leading Six Sigma organisations like Motorola, GE and AlliedSignal that the CEOs are the ones who have made it possible. Good examples of commitment of CEOs are Jack Welch of GE and Bob Galvin of Motorola whose executives adopted such a leadership approach (Henderson and Evans, 2000; Coronado and Antony, 2002; Goh, 2002; Chakrabarty and Tan, 2007). Goh (2002) illustrated that Six Sigma implementation has to be 'top-down' rather than initiated by a particular department or from the ground. The top executive must be part of Six Sigma. Thus he/she must change the agenda of upper management meetings so the quality initiative is right near the top. Six Sigma has to be part of every discussion on the performance of the business and Six Sigma results are discussed daily with his/her boss (Paul, 1999; Henderson and Evans, 2000).

Feigenbaum (1997) advised that the top executive must be consistent and continuous in effective Six Sigma implementation and obtaining the maximum possible Six Sigma results is not a short-term, 'instant-pudding' way to improve competitiveness. Implementing Six Sigma requires hands-on, continuous leadership. Six Sigma top executive involvements includes a continuous processes of envisioning the future of a coherent organisation mission, overseeing all development process and providing motivation towards facilitating, strengthening and integrating organisation culture and climate. Antony and Benuelas (2002) validated that management commitment and involvement were the most critical factors, as Six Sigma requires.

Continuous support and commitment from top management are crucial for the successful introduction and development of Six Sigma programmes (Pande *et al.*, 2000).Without that, the true importance of the initiative will be in doubt and the energy behind it will be lost (Pande *et al.*, 2000; Goldstein, 2001; Halliday, 2001; Coronado and Antony, 2002). In order to be successful in implementing Six Sigma, top management must be involved in the creation and management of the process management system and also participate in projects themselves (Eckes, 2000).

Paul (1999) and Henderson and Evans (2000) suggested that Six Sigma should be part of everybody's job, including top management (corporation, business unit or even department) (Coronado and Antony, 2002). Top management should support the Six Sigma initiative by personally spending time in every Six Sigma training event, speaking and answering questions raised by employees, dropping in (usually unannounced) during reviews, making site visits to observe at first-hand the degree to which Six Sigma is ingrained in the culture and monitoring Six Sigma project progress weekly through summary reports from the tracking database and monthly reviews with the Six Sigma team (Pande *et al.*, 2000; Coronado and Antony, 2002).

4.4.2 Formation of Six Sigma Organisational Infrastructure

In addition to continued top management commitment and involvement, there also needs to be a suitable and effective infrastructure in place to support the Six Sigma introduction and implementation programme within any organisation.

The organisational structure for Six Sigma consists of a hierarchy of roles, depending on the level of expertise which is identified by the belt system. The Six Sigma belt system is the responsibility structure used to develop and manage employees by clearly defining their roles and responsibilities and their benefits from participation in continuous improvement efforts, which may increase the employees' contribution to Six Sigma (Breyfogle *et al.*, 2003). The Six Sigma teams are highly trained, have undergone rigorous statistical training and lead teams in identifying and executing Six

Sigma projects. Those belt levels make sure that establishment and execution of Six Sigma projects are done seamlessly (Hoerl, 2001). Specific Six Sigma roles include various levels of expertise such as Six Sigma Champions, MBBs, BBs, GBs and team members and they have to include a diverse population of technical and non-technical people, managers and people from key business areas (Welch, 1996). They are the agents of change who should spread the Six Sigma philosophy throughout the organisation and operators who know their process better than anybody should also be familiarised with it since they are the main contributors of the quality in products and services (Antony, 2000). Full descriptions of Six Sigma Belt system roles are provided in the Glossary of Six Sigma Terms.

The belt system identifies the key roles of the people directly involved in applying Six Sigma (Pande *et al.*, 2000). The belt system must be applied throughout the organisation, starting with top management (i.e. the champions) and should be cascaded down through the organisational hierarchy. The good thing about the belt system is that everyone involved in the organisation is thus speaking the same language (Hoerl, 1998). It has helped to generate hundreds of projects, ranging across every function of the organisation (Bowman, 1997). Six Sigma improvement projects are carried out by teams composed of members performing the above roles (Harry, 2000; Henderson and Evans, 2000). Six Sigma includes offering differentiated training programmes to employees to increase training effectiveness (Linderman *et al.*, 2003).

4.4.3 Readiness for Organisational Culture Change

The importance of organisational culture is also explicitly addressed in the Six Sigma literature, where culture is seen as influencing the effectiveness of changes required for a Six Sigma implementation in an organisation (e.g. Breyfogle *et al.*, 2003; Coronado and Antony, 2002; Smith, 2003). Six Sigma requires substantial change in the way that an organisation operates and the people behave towards quality and quality improvement.

Organisational culture change readiness has been recognised as one of the CSFs or challenges in Six Sigma implementation (Antony and Banuelas, 2002; Coronado and

Antony, 2002; Kwak and Anbari, 2006). According to Rouda and Kusy (1995), an organisation should be ready for change and able to meet a number of conditions. There are three main elements: (1) dissatisfaction with the present situation, (2) a vision of what it is possible to do in the future and the first steps that an organisation can use to decide if it is, (3) readiness for change. These three components must all be present to overcome the resistance to change in the organisation. If an organisation is able to display these three components, it can begin the process of change.

Antony and Banuelas (2002) identified organisational culture as a key factor essential for successful Six Sigma implementation. Breyfogle *et al.* (2003) suggested that organisations should assess their current culture to identify the forces that drive the organisation towards Six Sigma implementation and those restraining it. Top management should then make strategic plans to enhance the drivers and overcome the restraining forces. Likewise, Coronado and Antony (2002) suggested that Six Sigma programmes may be resisted in an organisation if the organisation's culture is fear based. But Six Sigma programmes can thrive in an open and supportive environment where quality problems are viewed as improvement opportunities. In some cases, substantial change to an organisation's structure and infrastructure needs to take place (Coronado and Antony, 2002; Chakrabarty and Tan, 2007). Often this change can lead to conflict. The best way to tackle this resistance problem is through increased communication, motivation and education (Coronado and Antony, 2002).

Six Sigma implementation requires the right mindset and attitude of people working within the organisation at all levels. With a true cultural revolution in an organisation come the basic two fears on an individual level: fear of change and fear of not achieving the new standards. To overcome fear of change in any industrial environment, the people involved must understand the need for change. It would be ideal to create a communication plan that would address why Six Sigma is important and how the Six Sigma methodology works in organisations (Hendricks and Kelbaugh, 1998). It is also essential to restructure the organisation in order to drive the cultural change and make Six Sigma a part of everyday life.

Six Sigma involves substantial change in the organisation structure and infrastructure. Usually when important change occurs, the people in the organisation are afraid of the unknown and they do not understand the need for change. Statements such as; "We've tried this before but it doesn't work" or "It's the way we've always done this" are typical examples of strong resistance to change. Some organisation cultures are fear based, where mistakes are not allowed and employees are used to hiding defects. Six Sigma, on the other hand, flourishes in an open and safe environment where defects are seen as improvement opportunities (Erwin, 2000).

Organisation-wide change often goes against the strong values held by members in the organisation, that is, the change may go against how members believe things should be done. This behaviour can be the result of different factors of resistance of which Eckes (2000) identified four: technical, political, individual and organisational. It must be highlighted that creation of a Six Sigma culture is neither fast nor easy. It takes a long time; some organisations may take years to achieve a Six Sigma cultural transformation but it depends on the degree of current inefficiency and ineffectiveness in the organisation and of commitment of management and employees alike (Eckes, 2001a).

According to Henderson and Evans (2000), Jack Welch (GE CEO) created change in organisational culture and overcame employee resistance by changing the organisational structure at the top, investing in training, adjusting the reward and recognition system and using early communication to employees. Other organisations that have succeeded in managing change have identified that the best way to tackle resistance is through increased and sustained communication, motivation and education. It is important as well to get as much practical feedback as possible from employees, plan the change through detailed Six Sigma implementation milestones, delegate responsibilities when possible and empower people to make their own decisions. Welch and Byrne (2001) stated that, "Overall, Six Sigma is changing the fundamental culture of the organisation and the way to develop people."

4.4.4 Continuous Training and Education

Training is also one of the CSFs in effective Six Sigma implementation. It is recognised as the single most important factor in improving quality once the necessary commitment has been assured and accordingly training strategy should be addressed early, along with other strategies within the quality policy (Oakland, 2003). Quality begins and ends with training (Ishikawa, 1985). It is critical and the best way is to provide the communication in terms of the 'why' and 'how' of Six Sigma to people in the organisation as early as possible and give the opportunity to them to improve their comfort level through training classes (Hendricks and Kelbaugh, 1998) unleashing the employees into the world of Six Sigma (Henderson and Evans, 2000). Moreover, the organisation should look for the idea of passing from a trained organisation to a learning organisation (Coronado and Antony, 2002). Training also creates a sense of ownership for everyone in the organisation, whatever their level of involvement (Coronado and Antony, 2002).

Training should be part of the overall approach of Six Sigma implementation and can come in a variety of packages including outsourced and internally provided training. In support of outsourcing training, some think that cultural changes such as Six Sigma rarely come from within an organisation (Henderson and Evans, 2000). Whether training is outsourced or provided by internal employees, most successful organisations believe that training is worth the investment. Training and education give a clear vision and sense for people to better understand the fundamentals, tools and techniques of Six Sigma. Training is part of the communication techniques to make sure that managers and employees apply and implement the complex Six Sigma tools and techniques effectively (Coronado and Antony, 2002; Goh, 2002; Johnson and Swisher, 2003; Kwak and Anbari, 2006; Chakrabarty and Tan, 2007).

The training curriculum is customised and needs to be provided by identifying key roles and responsibilities of individuals implementing Six Sigma projects (Anthony and Banuelas 2002). The curriculum in the belt system varies from organisation to organisation and consultant to consultant; however, it needs to be provided by identifying the key roles of the people directly involved in applying Six Sigma. For example, the training for becoming a BB within Motorola is a minimum of one year. In order to be accredited to BB, candidates must complete an application form to demonstrate how they have met the requirements in both training and practice of Six Sigma (Ingle and Roe, 2001). In GE, the length of training is approximately 16-20 weeks. Qualification as a BB is very important when employees are being considered for promotion. In general, it appears that GE has a more structured approach to training than Motorola (Antony and Banuelas, 2002). Table 4.3 shows a comparison of roles, profiles, training and numbers of people trained in the belt system according to Air Academy Associates (1998), which is a Six Sigma training and consulting group.

Table 4.3: Comparison of role, profile and training in Six Sigma belt systems

	GB	BB	Champion
Profile	▪ Technical background. ▪ Respected by peers. ▪ Proficiency in basic and advanced tools.	▪ Technical degree. ▪ Respected by peers and management. ▪ Many of basic and advanced tools.	▪ Senior manager. ▪ Respected leader and mentor of business issues. ▪ Strong proponent of Six Sigma who asks right questions.
Role	▪ Leads important process improvement teams. ▪ Leads, trains and coaches on tools and analysis. ▪ Assists BBs. ▪ Typically part-time on a project.	▪ Leads strategic, high impact process improvement projects. ▪ Change agent. ▪ Teaches and mentors cross-functional team members. ▪ Full-time project leader. ▪ Convert gains into £.	▪ Provides resources and strong leadership for projects. ▪ Inspires shared vision. ▪ Establishes plan and creates infrastructure. ▪ Develops metrics. ▪ Converts gains into £.
Training	▪ Two three-day sessions, with one month in between to apply. ▪ Project review in second session.	▪ Four one-week sessions with three weeks in between to apply. ▪ Project review in sessions two, three and four.	▪ One week champion training Six Sigma development and implementation plan.
Numbers	▪ One per 20 employees (5 per cent).	▪ One per 50 to 100 employees (1-2 per cent).	▪ One per business group or major manufacturing site.

Source: Air Academy Associates (1998)

Hendericks and Kelbaugh (1998) pointed out that, besides hardware and software, the 'human-ware' side is needed to make productivity work. Training is a cornerstone and improved human input is critical in the productivity equation. Training should also take into account the culture and history of an organisation. The Six Sigma implementation requires rigorous training in statistical methods, analytical techniques and various measurement tools that will be helpful to the work of BBs and their Six Sigma project teams. Although training of BBs is a critical element in

Six Sigma implementation, the training should not occur too early in the implementation process. The specific type of training they will need may not be known until later.

4.4.5 Use of Proper Six Sigma Methodologies and Tools

Henderson and Evans (2000) claimed that during belt training, employees have to learn significant tools and techniques that help prepare and run the Six Sigma project. The key to achieving high quality conformance and to overcoming process-related problems is the use of statistical tools and techniques (Modaress and Aussari, 1989).

Six Sigma can be very beneficial to improving the bottom-line, if implemented wisely. However, if the techniques are not used wisely, there is a very large danger that the programme will be counterproductive and frustrating. Organisations can sometimes get so involved in how to count defects and report defect rates that they lose sight of the real value of Six Sigma, which is orchestrating process improvement and reengineering and bottom-line benefits through the wise implementation of statistical techniques (Breyfogle, 1999b).

Six Sigma organisations have to use the statistical tools within a structured methodology to gain the knowledge needed to produce better, faster and less expensive products and services than the competition (Breyfogle, 1999b), and be capable of choosing the most appropriate tools and techniques applicable to them (Pande *et al.*, 2000; Coronado and Antony, 2002).

Employees should be prepared with the proper tools to successfully approach and complete Six Sigma projects. A healthy portion of Six Sigma training involves introduction to the theory behind the typical use of and practical experimentation with three groups of tool sets required within the Six Sigma problem solving framework: team, process and statistical tools (Henderson and Evans, 2000). Team tools and process tools are those used to prepare the Six Sigma project leader with the team and leadership skills required through the run of the project. These tools also help the project leader to create a shared need for the project as well as establish an extended project team. Statistical tools and a disciplined methodology used by specially trained individuals can improve processes by helping identify potential causes for variation and then reducing variation and defects.

4.4.6 Teamwork

In reviewing the literature, teamwork again turns out to be a critical factor for Six Sigma success. The Six Sigma programme concentrates on the importance of partnering, team focus and participation, because it is beneficial to get a diversity of opinions and perspectives in dealing with quality issues. It is the different backgrounds, experiences and perspectives that make the team output more valuable than an individual decision (Thompson, 1998).

Teamwork is a fundamental element within Six Sigma. The value of teamwork formed by cross-functional teams will launch a sense of ownership, better communication, team working value and an overall view of the organisation (Coronado and Antony, 2002). As most of Six Sigma work is done at the project team level, teamwork is a very important aspect of Six Sigma culture. Therefore it is essential for organisations to focus on developing effective teamwork skills for their employees. It should be noted that focused training in cross-cultural skills makes a significant difference in team performance. In this regard, Dale (2003) argued that without teamwork, difficulty would be found in gaining the commitment and participation of people throughout the organisation.

Clarity of purpose is essential for teamwork. Good communication skills and various team-building techniques encourage interpersonal relationships required to accomplish most tasks in the workplace. Six Sigma emphasises the need to work together. Solutions arrived at by teams are generally thought to be better, more creative and foster commitment to the ultimate outcome (Morrow *et al.*, 1997).

4.4.7 Effective Communication

Communication is part of the cement that holds together the bricks of the Six Sigma process, supporting the principle of people-based management (Kanji and Asher, 1993). Effective communication is a means of overcoming resistance to management initiatives and maintaining enthusiasm for quality initiatives within the organisation. Effective communication is vital in aligning the workforce towards corporate expectations. Unclear and inconsistent communication results in employees, front-line and middle managers focusing on priorities which have little or no relevance to the organisational focus (Henderson and Evans, 2000).

Communication is the interaction (oral or written) between leadership and subordinates. Furthermore, effective communication is a critical factor in creating Six Sigma culture. Communication is essential to build awareness about Six Sigma throughout the organisation; this may be done through an organisation-wide announcement from the most senior executive within the organisation, through organisation intranet, circulation of success stories, newsletters, bulletins or any other communication channels. It is very important that everyone within the organisation knows what Six Sigma is and what its benefits are (Coronado and Antony, 2002).

According to Hendericks and Kelbaugh (1998), "It is critical to communicate both the why and the how of Six Sigma as early as possible, and provide the opportunity for people to improve their comfort level through training classes". Using effective communication helps to educate and pave the way for gradual change in any organisation. Henderson and Evans (2000) and Coronado and Antony (2002) also emphasise the importance of a communication plan to involve the personnel with the Six Sigma initiative by showing them how it works, how it is related to their jobs and the benefits from it. By doing this, resistance to change can be reduced.

Communication between top management and employees is critical to Six Sigma implementation. Six Sigma can be sabotaged when bureaucratic barriers combine with management misunderstandings of what Six Sigma needs if it is to function. If communication fails, Six Sigma fails, and this is more likely to happen when management, individuals or factions are not brought into the process. Communication of Six Sigma from top management to organisation members and the communication of commitments are inextricably linked in the quality process (Coronado and Antony, 2002).

A corporate communication strategy is essential to show personnel how Six Sigma will work in the organisation environment, what the benefits will be and how jobs will be affected by the changes. The intranet provides a forum for communicating information about Six Sigma, and other media, such as presentations and workshops, need to be devised, together with a medium for upward communication. At each stage of the implementation programme or as quick wins are identified, the results should be published. It is also essential, in order to maintain transparency, to publish and seek comments on problems and setbacks encountered. This will reduce the risk of the same mistake occurring again in other parts of the contracting and purchasing process as well as other Six Sigma projects elsewhere in the organisation (Henderson and Evans, 2000).

It is important to establish a communication programme that can describe what should be communicated by whom and how often. It would help organisations to propagate their business strategy, customer requirements and work team. After implementation of Six Sigma projects, it is best to publish results, but these should not be restricted to success stories but also admit and communicate setbacks. It will help other projects in the pipeline to avoid the same mistakes and learn from mistakes (Coronado and Antony, 2002).

4.4.8 Project Management Skills

Another key CSF in the implementation of Six Sigma is that project leaders must have some basic project management skills. As mentioned earlier, Six Sigma belt team players must be taught team tools, where project management skills are included. The Six Sigma project managers, Champions, BBs and GBs should consider the key elements of project management, such as time, cost and quality. Defining them will provide the team with the scope, aim and resources needed to deliver an improvement in the short-term, at the lowest cost and meeting the requirements needed (Coronado and Antony, 2002). To obtain this, they need to work in cross-functional teams in which facilitative leadership guides the team to contribute in reaching the business strategy by identifying customer requirements.

As Six Sigma is a project-driven methodology, it is good practice for the team members to have project management skills to meet the various deadlines or milestones during the course of the project (Antony and Banuelas, 2001). Most Six Sigma project failures are due to poor project management skills, setting and keeping ground rules and determining the project's roles and responsibilities (Eckes, 2000).

4.4.9 Project Prioritisation and Selection

According to Ingle and Roe (2001), as Six Sigma is a project-driven methodology, it is essential to prioritise projects which provide maximum financial benefits to the organisation. For many organisations, financial returns to the bottom-line are the main criterion. Therefore the projects should be selected in such a way that they are closely tied to the business objectives of the organisation as they help the organisation improve competitive advantage, business profitability and process cycle-time, throughput yield, etc.. In addition, it is imperative to keep projects small and focused so that they are meaningful and manageable (Coronado and Antony, 2002).

It is important to choose the right improvement project when working with Six Sigma. Pande *et al.* (2000) claim that a carefully chosen and well defined improvement project gives better and faster results. According to them, a successful Six Sigma project should fulfil three conditions:

1. There is a gap between current and desired performance.
2. The cause of the problem is not identified.
3. The solution to the problem is not predetermined, nor is the optimal solution known.

A Six Sigma improvement project has to be selected using two criteria: whether it can address the issues that are critical to an organisation's customers and whether it can bring substantial bottom-line benefits (Breyfogle *et al.*, 2001a). Six Sigma projects have to be carefully selected, planned and reviewed to maximise the benefits of implementation. The project has to be feasible, organisationally and financially beneficial and customer oriented (Anbari and Kwak, 2004). Six Sigma projects ideally should concentrate on a specific area of interest. Lynch *et al.* (2003)

suggested that larger projects, or projects targeting more than one area of concentration and taking more than three to six months, should be divided into separate projects with the spin-offs to be completed later or worked on in parallel as separate projects.

There are many criteria for project selection that look to measure the factors described. Harry and Schroeder (2000), for instance, suggest that project selection can be top down or bottom up and propose the following possible decision criteria for project selection (Harry and Schroeder, 2000; Coronado and Antony, 2002): DPMO, net cost savings, cost of poor quality (COPQ), capacity, cycle time, customer satisfaction and internal performance. Furthermore, after properly selecting projects, it is important to define their scope, limitations, individual roles and responsibilities, etc., showing what the team will be and will not be working on. Moreover, the project goals or objectives must reflect the critical quality requirements from customers. So there have to be proper criteria for the selection and prioritisation of projects. Poorly selected and defined projects lead to delayed results and also a great deal of frustration (Pande *et al.*, 2000).

The literature suggests that a key ingredient for successful Six Sigma implementation is project prioritisation and selection (Pande *et al.*, 2000; Banuelas and Antony, 2002). In addition, since different potential areas of improvement compete for scarce resources, organisations should select Six Sigma projects in such as way that they are closely tied to the business goals and strategy (Ingle and Roe, 2001).

Project selection is one of the significant success factors for organisations to focus on while implementing Six Sigma. A good project selection could mean the difference between a successful or unsuccessful Six Sigma implementation (Harry and Schroeder, 2000; Keller, 2001; Snee, 2001b). Project selection is the process of evaluating individual projects or groups of projects and then choosing to implement some set of them so that the objectives of the organisation will be achieved (Pande *et al.*, 2000). Selecting a project that is too large will cause valuable time to be lost during the definition phase, as BBs struggle to scope their projects and develop project charters that can be addressed using Six Sigma. In addition, projects should be linked to the right goals and impact on at least one of the major stakeholders' issues, e.g. growth acceleration, cost reduction or cash flow improvement. Good project selection is itself a process; if it is properly carried out, the potential benefits of Six Sigma can improve substantially (Pande *et al.*, 2000).

The selection of right projects in a Six Sigma programme is a major factor in the early success and long-term acceptance within any organisation. This factor becomes even more critical in a small and medium enterprise. If you do not have a rigorous and disciplined approach to selecting projects, there is a high probability that your efforts will flounder. According to Adams *et al.* (2003), "Doing BB training before project identification is the classic, getting the cart before the horse".

According to Davis (2003), the first step of Six Sigma project selection is the establishment of a cross-functional team, including the top management. The responsibility of the team or steering committee is to identify, prioritise, select, monitor and evaluate Six Sigma projects. The involvement of the top management helps to cascade down the organisation strategy into specific Six Sigma projects. In addition, it removes the challenges and barriers more effectively (Kelly, 2002).

The importance of selecting adequate sources and choosing the useful information to identify Six Sigma projects is seen as a key step in project selection. Adams *et al.* (2003) proposed seven main sources for identification of potential Six Sigma projects: customers, suppliers, employees, benchmarking, developments in technology, extension of other Six Sigma projects and waste.

Six Sigma projects often begin with the determination of customer requirements and it is essential to set project goals based on reducing the gap between the organisation's deliverables such as quality, delivery time, reliability and customer expectations (Pande *et al.*, 2000). Effective project selection is based on identifying the projects that best match the current needs, capabilities and objectives of organisations (Pande *et al.*, 2000). Projects are the primary vehicle used to drive improvements in quality and productivity. Selecting, managing and completing projects successfully are integral components of any business improvement effort. The selection of the right project is a vital factor for gaining early and long-term acceptance of the Six Sigma programme among the senior managers and other employees in any organisation. The project selection process within a Six Sigma programme should be listening to four important voices: the voice of the process, the customer, the strategic business goals and the stakeholders (Pande *et al.,* 2000). Snee (2001) identified the following as important criteria for improving project selection, which can produce significant financial impact for the organisation: areas to improve, effect on customer satisfaction and effect on the bottom line.

4.4.10 Integrating Six Sigma with Rewards and Recognition

Rewards and recognition are one of the most important steps of the quality improvement process (Crosby, 1979). They are one of the enablers which maximises employees' potential and involvement and, in doing so, becomes one of the main contributors to the organisation's journey to quality (Johnston and Daniel, 1991). In addition, they are an important factor in the formation of Six Sigma, to sustain and energise the interest of belt levels (MBBs, BBs and GBs) and to retain them within the organisation. They must be rewarded for their efforts and a compensation plan must be established (Brue, 2003b). The rewards can be monetary, such as money and shares, and non-monetary, by integrating promotion to performance and achievements. One of the notable strategic changes that CEO Jack Welsh implemented at GE was to link the promotional considerations of employees to GB training. For example, GE changed its incentive compensation plan for the entire organisation so that 60 per cent of the bonus was based on financials and 40 per cent on Six Sigma results; they also insisted that no one would be considered for a management job without at least GB training (Byrne, 2003). So, across all GE businesses, nobody will be promoted without the full Six Sigma training and a completed project. This also includes senior executives (Hendericks and Kelbaugh, 1998).

Some studies show that above 60 per cent of the top performing organisations practising Six Sigma link their rewards to their business strategies, while lower performing organisations create minimal linkage (Harry and Schroeder, 2000). At GE, for instance, for any manager to be considered for promotion, he/she has to be Six Sigma trained. Likewise, up to 40 per cent of top management bonuses are tied to their specific Six Sigma success (Henderson and Evan, 2000).

4.4.11 Integrating Six Sigma with Employees

Six Sigma involves employees in the organisation's continuous improvement efforts so that it can provide high quality products and services to the ultimate customers. So this supports the principles of continuous improvement and team work. Brue (2003b) pointed out that "Six Sigma promotes morale and a sense of self-esteem; it gives employees the opportunity to make a difference. Every employee is important in Six Sigma". Some will be involved in special roles and problem solving methods, increasing their background and organisation performance level.

Every individual in the organisation needs to understand his or her role in making Six Sigma happen (Crosby, 1979). In fact, the need to maximise the involvement of all employees is one of the basic principles of change implementation in an organisation. It involves the employees in having a common understanding of Six Sigma and the importance of their involvement to maintain the Six Sigma momentum. The critical importance of employees' involvement and empowerment in the Six Sigma process of an organisation is based on the belief that the best process innovation ideas come from the people actually doing the job. Employee involvement and empowerment are ensured through Six Sigma project teams' training at all levels and suitable rewards and recognition systems.

Employees have to be motivated and willing to accept responsibility for the quality of their own work. Implementation of a Six Sigma programme requires the right mindset and attitude in the people working at all levels within the organisation (Antony and Banuelas, 2001). The people within the organisation must be made aware of the changes. The results obtained by implementation of the programme must be made public and should not only be related to success stories but should also admit and communicate any stumbling blocks encountered. These measures will help other projects in the pipeline to avoid the same mistakes and to learn from the mistakes.

Employees also have to be motivated towards continuous improvement by management involving its employees in decision-making, listening to their ideas about quality improvement, rewarding them based on quality and skills, implementing quality circles and creating and using cross-functional teams (Saraph *et al.*, 1989; Flynn *et al.*, 1995; Anderson *et al.*, 2006). Besides, Six Sigma uses a structured approach in developing and managing employees for effective and efficient quality management. This clarifies the role and responsibility of employees in an improvement team (Breyfogle *et al.*, 2001b). Six Sigma is about developing competent employees for effective quality improvement (Pande *et al.*, 2000a; Bhote, 2003; Gale, 2003).

In addition, Six Sigma emphasises that the most efficient way to reach the external customer is to satisfy the needs of the internal customer and to treat the latter as a link within the chain that leads to the external customer (Lasslo, 1998). Respect among employees is another concept of paramount importance for the successful implementation of Six Sigma. Mistakes by employees need to be treated as learning opportunities as Six Sigma should always capitalise on opportunities for improvement.

An organisation will only be successful when those at the bottom cooperate. It is difficult to achieve the higher goals that globalisation demands unless employees from all levels perceive continuous improvement as a benefit and become committed to the goals (Tan, 1997). Employee involvement provides a powerful means of achieving the highest order needs of self-realisation and fulfilment (Evans and Lindsay, 2005a). Flynn *et al.* (1995) noted that employee involvement is the most significant variable in understanding the percentage of parts passing final inspection without requiring rework. Employees who have been trained, empowered and recognised for their achievements see their jobs and their organisations from a different perspective. Crosby (1979) argued that every individual in the organisation must understand his or her role in making quality happen. The need to maximise the involvement of all employees is one of the basic principles of changing implementation in an organisation (Thiagarajan and Zairi, 1997).

4.4.12 Integrating Six Sigma with Business Strategy

Six Sigma cannot be treated as yet another stand-alone activity. It requires adherence to a whole philosophy rather than just the use of a few tools and techniques of quality improvement (Dale, 2003; Coronado and Antony, 2002). Six Sigma projects must be targeted for process and product improvements that have a direct impact on both financial and operations goals of business strategies. It should be extended to other operations within an organisation. In every single project, the link between the project and the business strategy should be identified and it should also demonstrate in money figures the benefit of the project in financial terms and the way in which it will help the business strategy (Coronado and Antony, 2002). Even if the first efforts focus on fairly narrow problems, their impact on the whole business should be clear and then how projects and other activities link to customers, core processes and competitiveness (Pande *et al.*, 2000a; Coronado and Antony, 2002). Also, it should be linked to customers as it is important to them and tries to maximise value and performance. Along with integrating with suppliers, Six Sigma can expand beyond the organisation; particularly, one way to reduce variability is to have a few suppliers, with Six Sigma performance levels (Coronado and Antony, 2002). Moreover, the reward system is a useful way to encourage successful selection and implementation of Six Sigma projects.

By identifying what is important for the organisation, management can establish its own goals and objectives. Moreover, when defining a business strategy for the implementation of Six Sigma in any area in an organisation, it is important to examine its relationship to other areas within it and ensure an inter-integrating strategy is clearly defined.

4.4.13 Integrating Six Sigma with Customer Satisfaction

Customer satisfaction is vital for a Six Sigma system. Customer needs and expectations are the crucial criterion for implementing Six Sigma improvement projects (Breyfogle *et al.*, 2001a). Similar to the linkage with the business strategy, Six Sigma should also be linked to what is important to the customer. Customer focus is one of the major requirements in implementing Six Sigma, which is highly sensitive to requirements for customer satisfaction (Coronado and Antony, 2002; Goh, 2002a; Chakrabarty and Tan, 2007). So one CSF of a Six Sigma programme is its ability to link to the customers and projects should begin with the determination of customer requirements (Harry and Schroeder, 2000). However, Pande *et al.* (2000a) argued that before customer needs can be met successfully, there has to be a good understanding of the organisation and its linkage to various business activities.

Customer satisfaction can be achieved when all the customer requirements are met. Six Sigma emphasises that the customer requirements must be fulfilled by measuring and improving processes and products. Customer satisfaction is meeting and exceeding the needs and requirements of the customer. Meeting the needs of the customer, in the case of the external customer, means that the product or service must deliver its specified and desired features. Six Sigma improvement projects are supposed to focus on improvement of customer satisfaction which eventually gives increased market share and revenue growth. As a result of revenue growth and cost reduction, profit increases and commitment to the methodology and further improvement projects are generated throughout the organisation.

Six Sigma should begin and end with the customer. Six Sigma projects should begin with the determination of customer wants and requirements identified at the beginning of a Six Sigma programme and should be adhered to throughout (Coronado and Antony, 2002). In addition to integrating Six Sigma with an organisation's business strategy, it also needs to be linked to what is important to customer satisfaction and retention. Defining a customer's requirements is not an easy task as these can be ambiguous, subjective and poorly defined. To overcome this, together with project managers, there is a need to monitor key activities and it is through Six Sigma that this can be achieved (Pande *et al.*, 2000a; Coronado and Antony, 2002).

According to Peters and Waterman (1982), leading organisations align their corporate strategies to their customers' requirements. Satisfying customers' requirements better than the competition is widely recognised as a key to success in the marketplace. The process of integrating Six Sigma with the customer can be divided into two main steps:

1. Identifying the core processes and defining their key outputs.
2. Identifying and defining the customer needs and requirements.

4.4.14 Integrating Six Sigma with Suppliers

Many organisations implementing Six Sigma find it beneficial to extend the application of Six Sigma principles to management of their supplier organisation. Hendricks and Kelbaugh (1998) stated that any organisation cannot be a Six Sigma one without its suppliers' participation in the programme implementation. The key element of successful integration of suppliers into Six Sigma is obtaining manifest support from the highest levels of management in the supplier organisation. The Six Sigma approach is to have different suppliers in order to maintain reduced costs; however, one way to reduce variability is to have a few suppliers, with Six Sigma performance levels (Pande *et al.*, 2000a; Coronado and Antony, 2002). In addition, Six Sigma cannot just stop inside the organisation walls and suppliers must also participate in this drive for quality (Coronado and Antony, 2002).

Organisations supplying the Six Sigma organisations need to be aware of the implementation of Six Sigma and the impact on their business. The reduction in the preferred supplier list and developing closer working partnerships with suppliers will reduce costs and maintain quality. A particular concern is the use of subcontractors and organisations' management need to address this area if cost and quality savings are to be achieved.

An open, long-term relationship with suppliers is established to acquire their cooperation (Flynn *et al.*, 1995). Furthermore, Six Sigma acts to support strong supplier relationships to sustain the principles of a bottom-line benefit focus and goal setting. The Six Sigma organisations emphasise obtaining significant benefits from their Six Sigma projects, which requires the organisations to explore more avenues for improving quality, including those related to suppliers (Bhote, 2003). In addition, when working with the suppliers to improve quality, the Six Sigma organisation sets specific goals for the suppliers' quality to urge them to develop a sound quality management system and to improve the quality of their products and services.

4.4.15 Integrating Six Sigma with Information Technology (IT)

The majority of the Six Sigma authors maintain that there exists a strong relationship between Six Sigma and IT. On the other hand, some authors maintain that IT contributes little assistance to Six Sigma and that it is possible to manage knowledge without IT. Effective Six Sigma implementation requires an IT system to receive, organise and help translate information into effective decisions for the organisation. For such a system to be active and functional, it requires an underlying IT infrastructure (Antony and Bhaiji, 2005). The main roles that an effective IT system would be required to play are (Kendall and Fulenwider, 2000):

- Support for collection of data from the process.
- A means for effective communication and sharing of data/information across the organisation.
- An easily accessible database holding information regarding all ongoing and completed Six Sigma projects.
- An interactive training tool for employees to learn the Six Sigma methodology and the tools within the methodology for problem solving activities.
- On-line coaching for Six Sigma tools and techniques.
- Software packages to assist with the selection and prioritisation of projects.

4.4.16 Integrating Six Sigma with Financial Goals

The targeting of the organisations has a direct impact on financial, accountability and operational goals and requires a business support strategy to underpin Six Sigma implementation (Hoerl, 1998; Antony, 2004, 2006; Chakrabarty and Tan, 2007). Whilst the fiscal vision of most, if not all, is to achieve a reasonable annual growth in revenue year-on-year, there is no link between Six Sigma and the business strategy(Pande, 2000; Antony, 2004; Chakrabarty and Tan, 2007). Moreover, with the implementation of Six Sigma in the Middle East in its infancy, there is little cohesive direction for Six Sigma implementation in this area.

4.4.17 Integrating Six Sigma with Existing Initiatives

Continuous improvement is a philosophy that stresses the need to constantly look for improvement opportunities in all dimensions of an organisation. The standard tools to achieve continuous improvement are found in Six Sigma. Six Sigma focuses on reducing variability to increase quality of products and to thereby achieve high levels of customer satisfaction.

The majority of authors maintain that there exists a strong relationship between Six Sigma and existing quality and improvement initiatives. Six Sigma stresses the need to satisfy customer expectations by eliminating waste, reducing cost and raising level of quality while providing a consistent product or service to the market. Quality is defined as not just quality of products or services provided for sale but also quality of all interactions with customers such as invoicing, responding to service related questions, product support, etc..

4.4.18 Competitive Benchmarking for Six Sigma

Benchmarking is considered one of the CSFs of Six Sigma implementation. It is important for Six Sigma practitioners to understand the purpose and use of benchmarking. In addition, it is a way of discovering what is the best performance being achieved - whether in a particular organisation, by a competitor or by an entirely different industry. Thus they can help their organisations use the information to identify gaps in the organisation's processes in order to achieve a competitive advantage.

4.4.19 Use of External Consultants

Joyce (2004) argued that "Before organisations can begin any Six Sigma initiative they need problem-solving skills to address the difficulties in their organisation. Six Sigma is not inexpensive and often necessitates the use of external consultants or the development of a more comprehensive internal consultation unit (which trains BBs). An organisation considering a Six Sigma move should consult one of the more well-known Six Sigma consultant organisations that offer organisations pre-programmed training as well as ongoing programme development assistance".

Brue (2004) identified that when choosing a Six Sigma consultant, the consultant has to be able to:

- Challenge executives into rethinking their existing business model and strategy to drive growth and be willing to walk away if full support is not given.
- Insist that everyone be part of the Six Sigma process.
- Validate project savings and show how Six Sigma turns dates into growth for the organisation.
- Assess opening the potential savings with enough confidence to guarantee a minimum saving equal to 20% of an organisation's revenues and to accept the risk of being compensated on the basis of this.

4.5 Chapter Summary

This chapter has presented and overviewed what are CSFs. Then, it reviewed the previous studies and literature of CSFs for Six Sigma implementation. Furthermore, it has identified the CSFs for effective implementation of Six Sigma projects and best practice in the literature by comprehensive analysis of various journal papers, books and case studies. All the factors discussed above are equally applicable to services as they are to manufacturing. To summarise, these CSFs are very important to take into consideration before implementing any Six Sigma project. The next chapter (Chapter 5) will present the research design and methodology for this study.

CHAPTER 5

RESEARCH DESIGN AND METHODOLOGY

CHAPTER 5

RESEARCH DESIGN AND METHODOLOGY

5.1 Introduction

The preceding chapters, Chapters 2, 3 and 4, presented a review of literature covering the main issues related to this research. This chapter deals with presenting, identifying and discussing the details of the research design and methodology needed by the researcher in this study. First, it gives an overview of scientific research (Section 5.2). Then, it discusses the research strategy (Section 5.3) and research approach (Section 5.4) selected for this study. In addition, it presents and discusses the research design and methodology used in this research (Section 5.5), and the sampling method will also be presented (Section 5.6). It also critically discusses the data collection (Section 5.7) and data analysis (Section 5.8). Furthermore, it considers the research measurement issues and credibility testing (Section 5.9). It also discusses and reviews research ethical issues (Section 5.10). Finally, the chapter ends with a summary (Section 5.11). Figure 5.1 shows the structure of the chapter.

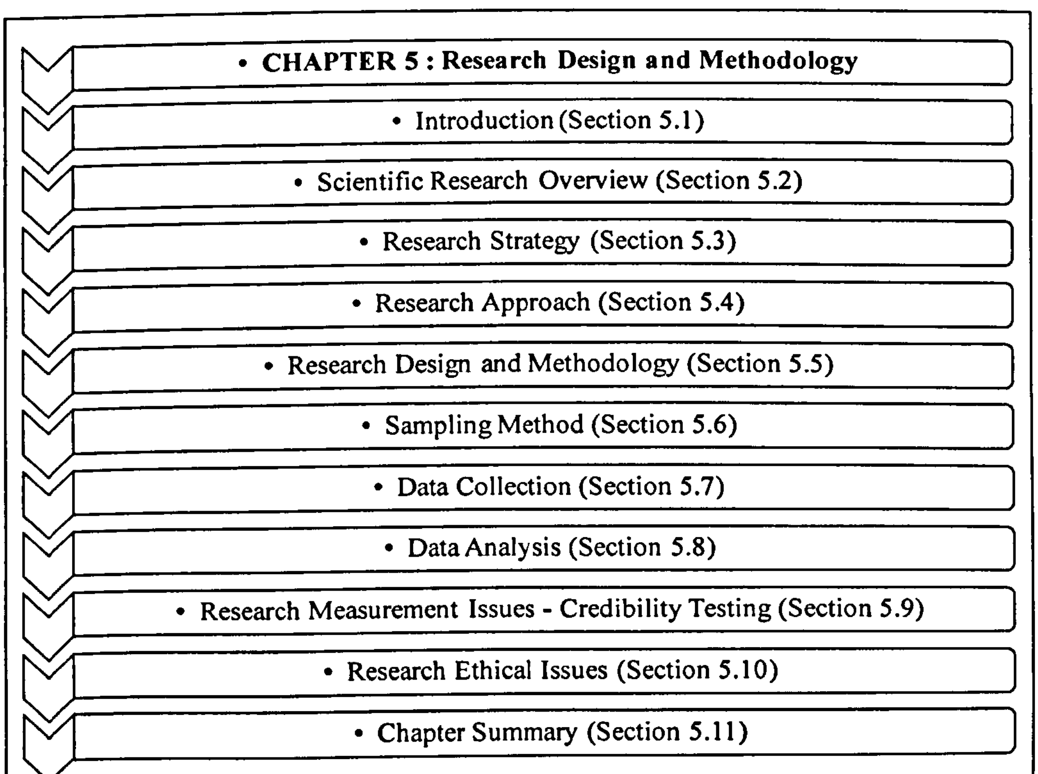


Figure 5.1: Structure of Chapter 5

5.2 Scientific Research Overview

According to Hussey and Hussey (2003), there is no agreed definition in the current literature on how research should be defined. However, Sekaran (2003) stated that research could be defined as an organised, systematic, scientific, data-based, critical, scientific inquiry or investigation into a specific problem, undertaken with the objective of finding answers or solutions to it. On the other hand, Mason and Bramble (1989) described the planning and designing of research as recognising the centrality of the research question in the research process and of integrating research questions with one's own philosophical and methodical position on the one hand and appropriate data generation methods on the other. In addition, according to Aaker *et al.* (1997), the specific aims of any research usually depend on what is being investigated.

Sekaran (2003) stated that research processes must be carried out systematically, diligently, critically, objectively and logically. Nachmias and Nachmias (2000) described the role of research as an attempt to increase the body of knowledge by discovering new facts or relationships through a process of systematic scientific inquiry. The expected results of the research would be to discover new facts that will help to deal with the problem situation (Sekaran, 2003). Therefore, the role of scientific research is to fill a gap in a particular subject and to ensure that something new and important has been added to the body of knowledge (Hussey and Hussey, 2003).

Furthermore, Nachmias and Nachmias (2000) defined a research problem as an intellectual stimulus calling for an answer in the form of scientific inquiry. Sekaran (2003), on the other hand, defined a research problem as any situation where a gap exists between the actual and desired state.

Many experts on research agree on three main purposes and methods for carrying out research, namely *Exploratory*, *Descriptive* and *Explanatory* research, depending on the nature of the research problem and its structure (Robson, 2002; Saunders *et al.*, 2003; Yin, 2003; Babbie, 2004). In addition, Robson (2002) pointed out that the purpose of an enquiry may change over time, which means a study may include more than one purpose. Exploratory researches try to build descriptions of complex circumstances or phenomena unexplored in the literature (Marshall and Rossman, 1999). Thus, exploratory studies are often made to clarify the nature of vague problems. Saunders *et al.* (2003) explained that exploratory researches tend to start with a wide research area and narrow down as the research develops. Robson (2002) argued that exploratory researches are a valuable means to find out what is happening, to seek new insights, to ask questions and to assess phenomena in a new light. Correspondingly, Yin (2003) considered that by an exploratory research we mean a study of a new phenomenon. Exploratory research is characterised by formulating problems more precisely, clarifying concepts, gaining insight, eliminating impractical ideas and forming hypotheses, although it does not seek to test them (Neuman, 2004). Ultimately, in exploratory research, flexibility is very apparent; it can be done by using a literature search, surveying certain people about their experiences and making case studies (Yin, 2003).

The idea of exploratory research is to get a better understanding and to clarify the nature of an ambiguous research problem or investigate a new topic on which little research is found and is aimed at generating hypotheses for other research types, like the descriptive and the explanatory (Trochim, 2001; Neuman, 2003). Babbie (2004) stated that the exploratory approach to research is typical when a researcher examines a new interest or when the subject of study itself is relatively new, which was the case in this research. According to Sekaran (2003), an exploratory research is used when not much is known about the situation at hand or when no information is available on how similar problems or research issues have been solved in the past; thus, its purpose is to understand better the nature of the problem.

Based on the study purpose and its objectives, this study will be exploratory research to gain insight into the research problems and to identify key issues regarding Six Sigma implementation in the Middle East.

5.3 Research Strategy

Research strategy can be defined as a general plan of how the researcher will go about answering the research question(s) (Saunders *et al.*, 2003). According to Aaker *et al.* (1997) and Nachmias and Nachmias (2000), social research encompasses two major fundamentals: empirical and theoretical. In empirical study, the researcher observes phenomena in depth and collects information in order to reach a conclusion, adding value to knowledge. In contrast, theoretical study is based on others' writings and here the researcher attempts to benefit from their ideas and uses his/her abilities to come up with a new or different view of the situation that also contributes to knowledge. So, this research study is an empirical one.

Nachmias and Nachmias (2000) argued for the two types of research strategy, research-then-theory and theory-then-research, which can also be called inductive and deductive research, respectively. Yates (2004) stated that, in the inductive approach, the researcher begins with concrete empirical details and then works towards abstract ideas, models or general principles. On the other hand, in the deductive approach, the researcher relies on theory and the literature as a foundation for the new research and formulates hypotheses later tested with the help of empirical data. Moreover, Zikmund (2003) has differentiated between them: the deductive approach implies that a conclusion is derived from a known premise or something known to be true but the inductive approach implies that general propositions are established on observation of particular facts. Saunders *et al.* (2003) explained that research uses the inductive approach when the researcher collects data and develops theory as a result of the data analysis, while the deductive approach is where the researcher develops a theory and a hypothesis and designs a research strategy to test the latter. Deductive logic analysis involves drawing from ideas or theories already established in one context and making conclusions about them in another.

So, this research study is a theory-then-research type which uses a deductive type of strategy because it is exploratory in nature. The literature review provides the theoretical basis for the strategy which then proceeds to reveal answers to the research questionnaire through results of interviews and culminates in proposal of a general model for successful and effective implementation of Six Sigma in Middle East organisations.

5.4 Research Approach

Designing a research study involves a choice of research approach. Therefore it is appropriate to discuss the research approach before discussing the research design. Selecting the research approach is one of the most critical phases a researcher should be aware of when seeking answers to a problem. There are two common methodological approaches in social sciences: quantitative and qualitative (Nachmias and Nachmias, 2000; Trochim, 2001; Creswell, 2003; Saunders *et al.*, 2003; Yates, 2004). The following sub-sections provide detailed information concerning the quantitative and qualitative methodologies.

5.4.1 Quantitative and Qualitative

Quantitative and qualitative research are simply different ways of conducting social research, each of which may be most appropriate for different kinds of research questions (Robson, 2002). Quantitative research is based on a numerical measurement of specific aspects of phenomena. It is a very structured approach (Creswell, 2003). In contrast, qualitative research is based on intensive study of as many features as possible of a small number of phenomena. It seeks to build understanding in depth (Collis and Hussey, 2003). In addition, according to Huberman and Miles (2002), data collected can be classified as qualitative if they come in word form and describe situations, individuals or circumstances surrounding a phenomenon, while they are viewed as quantitative if they are in the form of numbers, often counts or measurements, that attempt to give precision to a set of observations.

Both qualitative and quantitative approaches in this study provide advantages and they can offer these in the depth of insight in explanation of behaviours and attitudes. Quantitative research is considered to be the core of the research and it can be defined as involving the use of structured questions where the response options have been predetermined and a large number of respondents are involved. Furthermore, Saunders *et al.* (2003) argued that quantitative research seeks to quantify the data and, typically, apply some form of statistical analysis.

In contrast, qualitative research is an unstructured, exploratory research methodology based on small samples providing insights and understanding of the problem setting and involves collecting, analysing and interpreting data by observing what people do and say (Creswell, 2003). The quantitative approach consequently looks over social processes and focuses solely on social structure by isolating the problem from its setting. This approach has been quite popular with researchers until recently, when it was heavily criticised for these reasons by those who prefer qualitative research (Hussey and Hussey, 2003).

The quantitative approach places considerable emphasis on statistical generalisation of findings that seeks to explain and predict events in the social world by searching for regularities and causal relationship between constituent variables (Yates, 2004). The collected material is coded and analysed objectively and considered to be more reliable (Trochim, 2001). Moreover, quantitative research is concerned with discovering a causal relationship, prediction or explanation of a relationship comparing or relating several variables under investigation (Creswell, 2003). However, a major weakness with this approach is that it is not possible to go in depth into every area at the same time since it is standardised and therefore does not give any room for interpretations and new angles (Robson, 2002). On the other hand, quantitative approaches are more structured and formal. Nachmias and Nachmias (2000) characterised a quantitative research approach as theory-before-research and a qualitative research approach as research-then-theory. Oppenheim (1996) defined quantitative research as a form of planned collection of data for the purpose of description or prediction as a guide to action or for analysing the relationship between certain variables.

Qualitative research is a broad term that describes research focusing on how individuals and groups view and understand the world and construct meaning out of their experiences. According to Neuman (2004), qualitative research focuses on understanding phenomena and describing both the meaning and implications of events. A qualitative approach also works as a useful planning tool for a subsequent quantitative approach. Rossman and Rallis (1998) identified qualitative research as seeking to answer questions with the purpose of learning and generating new understandings that can be used in the social world. Qualitative research implies soft data, such as atmosphere at work, often presented as words and observations, while quantitative implies hard data, like information on profits gained and order size, often presented as numbers that will determine the quantity or extent of some phenomena (Robson, 2002).

In discussing qualitative and quantitative data collection methods, Hussey and Hussey (2003) stated that some researchers prefer a quantitative approach which is objective in nature and concentrates on measuring phenomena. Therefore, a quantitative approach involves collecting and analysing numerical data and applying statistical tests. Others prefer a qualitative approach, which is more subjective in nature and involves examining and reflecting on perceptions in order to gain an understanding of social and human activities. According to Lee (1992), one of the most fundamental distinctions often stated is that the quantitative approach is objective and the qualitative is subjective. It is generally agreed in the literature that each of the methods has its own advantages (strengths) and disadvantages (weaknesses) presented in Table 5.1.

Table 5.1: Advantages and disadvantages of quantitative and qualitative approaches

	Quantitative Approach	Qualitative Approach
Advantages (Strengths)	▪ Higher level of accuracy ▪ Provides factual information ▪ Results more significant and focused, both as to information gathered and target audience used ▪ Can establish within significant margin of error facts about given population	▪ Relatively fast ▪ Can be simpler to undertake ▪ Can be cheaper than quantitative as small scale ▪ Helpful information as forerunner to qualitative research ▪ Overall when used skilfully good value for money Offers useful overview
Disadvantages (Weaknesses)	▪ Slower than qualitative ▪ Can be more expensive ▪ Problems of low response rates, so large sample sizes required to get good results ▪ Often requires computer analysis ▪ Some risk of bias ▪ Not so simple to undertake	▪ Findings more subjective, calling for higher level of interpretative skills ▪ Smaller sample sizes reducing statistical accuracy levels ▪ Greater chance of bias from respondents and through interpretation

Source: Ghauri *et al.* (1995)

5.4.2 Triangulation

To avoid the weaknesses of quantitative and qualitative methods and to enhance their strengths, the researcher has used a multi-method mode of data gathering termed methodological triangulation. Triangulation is the use of two or more research sources, methods, investigators or theories to examine the same problem (Flick, 2002; Robson, 2002; Yin, 2003). Researchers use triangulation to validate their results, which allows them to be more confident in them (Brannen, 1995). In addition, Bryman (2004) argued that triangulation allows the researcher to capture a more complete, holistic and contextual description of the topic under study. Patton (1990) argued that studies using only one method are more susceptible to error linked to that particular method. Bryman (2004) claimed that each of the qualitative and quantitative methods has several features which can be regarded as advantages or disadvantages. By using triangulation, researchers claim that the validity of conclusions is enhanced if the results can be shown to provide mutual confirmation (Bryman, 2004).

Neuman (1994) described triangulation as using different types of measures or data collection techniques in order to examine the same variable. In addition, Collis and Hussey (2003) defined triangulation as the combined use of different approaches, techniques and methods in the same study. They argue that the use of different methods in studying the same phenomenon should lead to greater validity and reliability than a single methodological approach. In addition, Smith (1981) stated that triangulation among methods usually involves replication for purposes of reliability and theory conformation. Bryman (2004) added that researchers are likely to exhibit greater confidence in their findings when these are derived from more than one method of investigation. In addition, Hussey and Hussey (2003) argued that triangulation has vital strengths, encourages productive research, enhances qualitative methods and allows the complementary use of quantitative methods.

Selection of one technique or the other, or both, is based on the nature of the research questions chosen (Ghauri *et al.*, 1995). The multiple method approach is recommended by many social researchers such as Sekaran (2003) and Saunders *et al.*

(2003). There is however no single design or method that is better than others. Each type has its particular advantages and disadvantages and the combination meeting the nature of the issue or question under examination should be selected accordingly.

In any research, having the quantitative and qualitative approaches together adds value to the research. Remenyi *et al.* (2000) supported this and indicated that researchers should be ready to draw on both approaches in order to address different aspects of a research problem. Use of different methods in studying the same phenomenon should lead to a greater validity and reliability than a single methodological approach, because any bias expected in a particular method would be neutralised when used in conjunction with other methods. For this reason, in this study, the researcher decided to use triangulation combining survey questionnaire as the preferred quantitative method and interviews as the chosen qualitative data collection method, in order to increase the validity and credibility of the research conclusions, be more confident about the findings, increase the ability of generalisation, answer the research questions and meet the research objectives effectively and professionally. This is particularly important since, to the researcher's knowledge, there has been no other research in the field of Six Sigma in the Middle East and there is a lack of scientific studies in this field in general.

So the researcher believes that triangulation in this research based on survey questionnaire and interview analysis is crucial. The two methods are complementary to each other and the strengths and weaknesses of each method are considered. The purpose of this was to provide a means of validating information derived from different sources and permits the strengths and weaknesses of different data collection methods to be balanced. The adoption of such an approach has the following advantages:

- Use of an interview alongside the questionnaire gives additional information and aids the analysis of the major issues in the sample of organisations selected.
- It is able to take place in conjunction with the literature and the secondary research sources, i.e. interviews are a valuable way of triangulating data collected by the questionnaire. This will help to reduce the inevitable bias which influences qualitative, subjective analysis.

5.5 Research Design and Research Methodology

A schematic view of the research design and methodology to achieve the objectives of this research is illustrated in Figure 5.2.

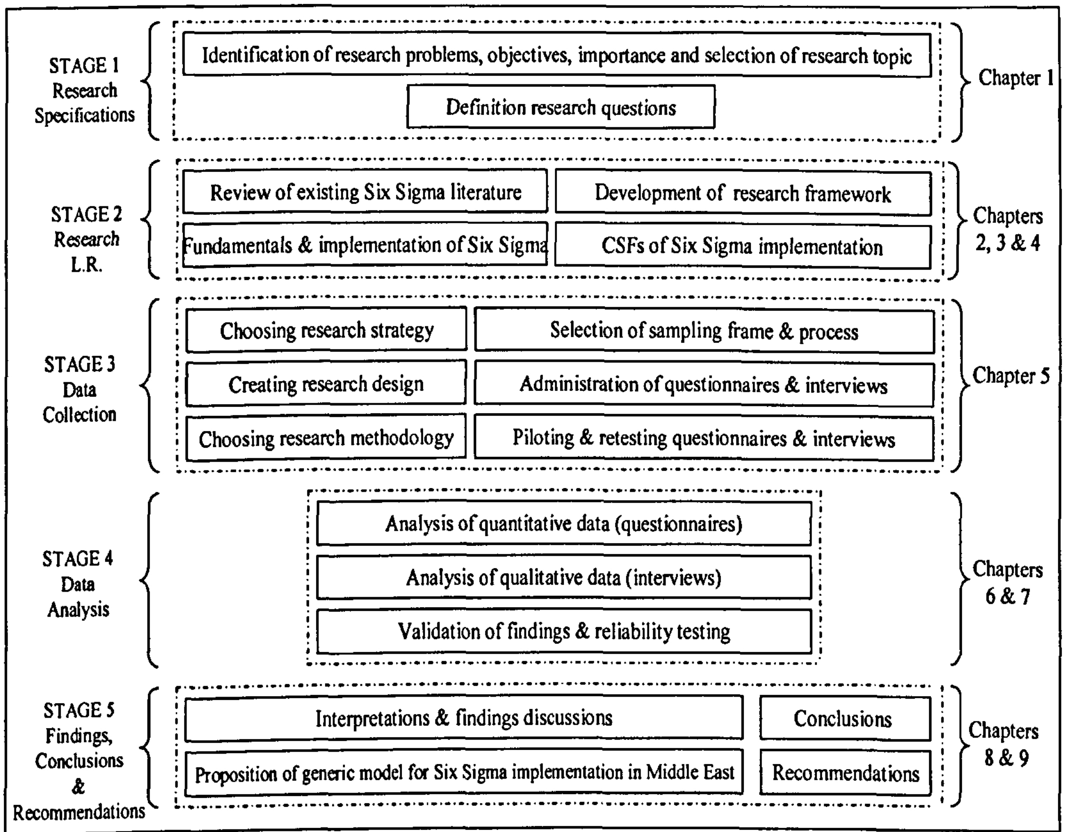


Figure 5.2: Overview of research design and methodology

5.5.1 Research Design

Various definitions are provided for the term research design in the literature, some broad, others narrow. To clarify this, a few definitions are quoted for the sake of clarification. According to Churchill (1999), research design is the framework or plan for a study, used as a guide in collecting and analysing data. For Yin (2003), research design is the blueprint that enables the researcher to come up with solutions to possible problems and acts as guidance in various stages of a research. He also defined research design as the logic that links data to be collected and the conclusions to be drawn to initial questions of the study and a plan for assembling, organising and interpreting information and its results in a specific product. In addition, according to Nachmias and Nachmias (2000), research design is the programme that guides the researcher in the process of collecting, analysing and interpreting research observations and is concerned with the research to be conducted, type of investigations that will be carried out, what the sample would be and levels and means of data collection and analysis. Accordingly, research design deals with at least four problems of carrying out a successful research: what questions to study, what data are relevant, what data to collect and how to analyse the results (Yin, 2003). Therefore, research design covers strategic decisions concerning the choice of data collection methods and more tactical decisions regarding measurement and scaling procedures, questionnaire, samples and data analysis (Zikmund, 2003). However, research design has both a general and a specific meaning. The general meaning of research design refers to the presentation of the plan of the study methodology and its specific meaning refers to the type of study (Nachmias and Nachmias, 2000).

In a common sense, research design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions. A research design is therefore an action plan for getting from the initial set of questions to be answered to some set of conclusions (answers) about these questions (Nachmias and Nachmias, 2000). It also makes sure that the study is relevant to the problem and uses economical procedures. Research design provides a conceptual framework for the study, while research methodology is concerned with the tools used to achieve each specific aim. It provides a framework that guides data collection and data analysis.

According to Burns and Bush (1995), every research must define its chosen research design, because without it there is no clear direction as to what and why data are collected. Conducting a research without a research design is likely to cost more and may not solve the problem under investigation (Burns and Bush, 1995). In other words, a research design contains the objective(s) of the study, determined during the early stages of the research, the sources of information, design technique, sampling methodology and cost of the research, so that the information gathered is appropriate for solving the research problem.

The research design developed for this study is guided by many of the issues which arose in the literature review and is divided into the following sections:

- Review of existing body of Six Sigma literature.
- Identification of the research problem.
- Quantitative research through survey questionnaire.
- Qualitative research through semi-structured interviews.
- Analysis and discussion of findings.
- Development of a proposed generic model for successful and effective implementation of Six Sigma in the Middle East context.

According to the above discussion, the research design identified for this study is more holistic and includes research methodology, since it is more related to its strategic issues. Choosing the right research design for a study is not just picking up any design and applying it. So the design of this research is exploratory, since the overall aim of the research is to investigate the current status of the implementation of Six Sigma in the Middle East and to what extent the implementation is successful and effective in the Middle East context.

5.5.2 Research Methodology

Robson (2002) defined methodology as a set of procedures and rules to guide research and against which its claims can be assessed. The methodology of any research underpins the values and assumptions forming the research rationale. It also directs the criteria that the researcher chooses to use for collecting and interpreting data. Saunders *et al.* (2003) referred to the methodology as the systematic and logical study of the principles guiding scientific and philosophical investigation. Nachmias and Nachmias (2000) were very brief in defining methodology: "A system of explicit rules and procedures on which research is based and against which claims of knowledge are evaluated."

There is no right or wrong methodology but the researcher should seek the most beneficial method available. Selecting a methodology is dependent on different factors, including the nature of the study and the purpose of the research. The choice of methodology is the most important choice in the research design and it depends on the nature of the research problem.

As the research design depends mainly on factors such as the purpose of the research, the research questions, etc., the choice of the research methodology also depends on the same factors. Research methodology presentation should include sampling design, data collection, data analysis and limitations or constraints that the research faced (Cooper and Schindler, 2003). Choosing the right research methodology depends on some criteria such as the aim of the study, the type of information needed, the character of respondents, manipulation of independent variables, the degree of control that the researcher has over the case under study and constraints of time and money (Saunders *et al.*, 2003). According to Yin (2003), the choice of research methodology depends mainly on three conditions: first, type of research questions, second, control an investigator has over actual behavioural events and, finally, focus on contemporary as opposed to historical phenomena.

5.6 Sampling Method

5.6.1 Sampling Definition

Sampling is one of the critical research design decisions (Sekaran, 2003) and its purpose is to enable researchers to estimate some unknown characteristics of the population. Sampling, as defined by Zikmund (2003), is the process of using a small number of items or parts of a whole population to make conclusions regarding the whole. It is the process of obtaining information from a subset of a large group, whereas a sample is a subset of all the members of a population of interest (McDaniel and Gates, 2002). Likewise, Sekaran (2003) described it as the process of selecting a sufficient number of items from the population so that by studying the sample and understanding the properties or characteristics of the sample subjects, we will be able to generalise the properties or characteristics to the population elements.

It allows the researcher to identify some vague, unknown characteristics of the population. Carefully selected samples can be sufficiently accurate and representative (Zikmund, 2003). The primary factor for any sample to be accurate is that it must be as representative as possible of the population from which it is drawn. A sample is considered to be representative if the analyses made using the researcher's sampling units produce results similar to those that would have been obtained had the researcher analysed the entire population (Bryman, 2004).

In this study, the researcher's aim is to understand how far Middle East organisations are a Six Sigma organisation, so based on that aim, 44 Middle East Six Sigma organisations, regardless of their size or industry sector, were considered as the sample for this study.

5.6.2 Sampling Methods and Techniques

The selection of the most appropriate sampling technique is one of the most important steps in carrying out any study, since it directly affects the results. There exist a number of types of sampling and techniques for the selection of samples from the study population, according to the nature of the population and the type of study. It is crucial for researchers to find the best way in which the sample is to be selected. Sampling methods (techniques) can be classified into two broad categories: probability and non-probability sampling. The probability sample is one that permits specifying the probability that each sampling unit will be included and the non-probability sample is one in which there is no way of specifying the probability of each unit's inclusion in the sample (Neuman, 2004). The appropriateness of a sampling method depends on the aims and objectives of the study. If the aim is to generalise to an entire population and to provide a statistical basis for asserting that the sample is representative, a probability sample is appropriate. If the aim of the study is, on the other hand, to learn about individuals or cases for some purposes other than generalising to a population or if random selection is not possible, then non-probability sampling is appropriate.

5.6.2.1 Probability sampling

The probability sample is based on chance selection procedures. In probability sampling, every element in the population has a known non-zero probability of being selected and the selection of probability samples will always respect certain statistical rules that are not subject to the interference of the researcher (Sekaran 2003). Because of its randomness, probability-sampling procedures eliminate the bias associated with non-probability sampling (Remenyi *et al.*, 2000; Zikmund, 2003). One of the advantages of using probability sampling is that it allows the sophisticated use of statistical tests to search for group differences. In probability sampling, a sample is selected in such a way that every case has a known chance of being selected. Probability samples allow for computation of the confidence that the sample and the findings drawn from it are representative of the larger population. There are five types of probability sampling methods (Remenyi *et al.*, 2000; McDaniel and Gates, 2002): simple random sample, stratified random sample, systematic random sample, cluster random sample and multistage random sample.

5.6.2.2 Non-probability sampling

Non-probability sampling, based on the subjective judgements of the researchers, is usually used in exploratory research (Remenyi *et al.*, 2000). In this type of sampling, it is unlikely to specify or categorise the probability of each unit in the sample. This implies that there is no chance for units to be selected (Nachmias and Nachmias, 2000). In non-probability sampling, a sample is drawn in a way that does not give every member of the population a known chance of being selected. In other words, members are selected from the population in some non-random manner. In non-probability sampling, the probability of any particular member of the population being chosen is unknown. The selection of sampling units in non-probability sampling is quite arbitrary, as researchers rely heavily on personal judgement. Nevertheless, there are occasions when non-probability samples are best suited for the researcher's purpose (Zikmund, 2003). They can be useful when random sampling is not possible or when the population is small. In a non-probability sample, there is no expectation that each unit will have an equal chance of being included in the sample. It can yield very useful information when cases are selected thoughtfully, as they have been for this study. In non-probability sampling, the degree to which the sample differs from the population remains unknown. Non-probability methods include purposive sampling, accidental sampling, convenience sampling and quota sampling (Nachmias and Nachmias, 2000).

Several motives urge researchers to adopt non-probability sampling over probability sampling, even though the latter has more advantages. Firstly, if the objective of the research is not a true cross-section of the population then there is no need to generalise the findings of the study to the population (Sekaran, 2003). The second reason for choosing non-probability over probability sampling is that probability sampling is costly in both time and money. Probability sampling requires more planning and repeated call-backs to ensure that each selected element of the sample is contacted. All these activities are expensive and require sufficient financial resources. Thirdly, if the total population may not be available then non-probability sampling might be the only feasible alternative for the researcher (Cooper and Emory, 1995).

5.6.2.2.1 Purposive sampling

Purposive samples, also called judgement samples, are samples in which the selection criteria are based on the researcher's personal judgement about the representativeness of the population under study (Nachmias and Nachmias, 2000; Remenyi *et al.*, 2000; McDaniel and Gates, 2002). According to Schutt (1996), this kind of sampling is not representative of the population, since it restricts itself to a particular class or group and not to all classes of the sample. This type of sampling is employed if the researcher desires to arrive at information from a particular segment of the population (such as experts in a particular field).

Purposive sampling is ideal when researchers select sampling units subjectively in an attempt to obtain a sample that appears to be representative of the population. In other words, the chance that a particular sampling unit will be selected for the sample depends on the subjective judgement of the researcher (Nachmias and Nachmias, 2000).

In this study, a non-probability sampling purposive (judgement) sampling design has been adopted. A decision was made to choose the Middle East Six Sigma organisations to represent the sample for this study. The motives behind this selection were the following:

- Members of top management of Middle East Six Sigma organisations are very well educated, have expert knowledge and seem more able to provide the type of information required for this research.
- Six Sigma certified/qualified persons are more likely to be familiar with Six Sigma applications and its impact on some organisations more than others.

5.6.3 Sampling Frame and Selection

The sampling frame is comprised of a complete listing of elements or units from which the sample is to be drawn. The sampling frame, ideally, should include all sampling elements or units in the population. In practice, such a physical list rarely exists; researchers usually rely on a substitute list (Nachmias and Nachmias, 2000).

In this research, the selection process involved finding a mixture of organisations varying in size, maturity of Six Sigma implementation and scope of business. This was deemed necessary to obtain responses covering different industries in order to make sound generalisations about the whole sample.

The sample of this research consisted of 44 organisations in the three selected Middle East countries chosen because they provided a suitable setting to investigate Six Sigma implementation in the Middle East and met the selection criteria. These organisations were large organisations and SMEs from both manufacturing and services sectors. Respondents were from Saudi Arabian, Egypt and UAE organisations that had implemented Six Sigma and who were directly involved in the implementation process.

5.6.4 Sample Unit, Sample Size and Response Rate

5.6.4.1 Sample unit

A unit of sample or a unit of analysis is the unit from which information is obtained and whose characteristics we describe (DeVaus, 1996). For the objectives of this study, the unit of analysis was the Middle East organisation that had already implemented or was planning or in the process of implementing Six Sigma. The sample was targeted on the personnel top management (CEO and managers) and Six

Sigma certified or qualified persons (Green Belts, Black Belts, Master Black Belts and the Champions) who had been involved in Six Sigma implementation. Because of the conservative nature of Middle East society, especially in Saudi Arabia, and because the majority of the targeted samples in both sectors are males, female employees were not included in the study sample.

5.6.4.2 Sample size

When planning a study, a stage is reached when it becomes necessary to make a decision about the size of the sample. This decision is important, because a very large sample represents a drain on resources, while a very small sample reduces the value of the results. Determination of the size of the sample is dependent on a number of basic principles, including the goals of the study, financial and human resources, time available for data collection, as well as the chosen sampling technique. But also it depends on two key factors: the degree of accuracy required for the sample and the extent to which there is variation in the population in regard to the key characteristics of the study (Emory and Cooper, 1991; DeVaus, 1996). Sample size is a crucial issue for statistical analysis. Given the objectives of the research, emphasis was placed on obtaining an adequate sample for analysis.

Bryman and Cramer (2001) argued that a large and adequate sample size should be taken to remove bias and to meet the criteria required by the analytical methods used. In addition, they emphasised that the size of the sample has to be related to the size of the population. They also believed that the larger the sample, the greater the accuracy. On the other hand, Comrey (1973) suggested that a sample in excess of 200 is fair, a view echoed by Tabachnick and Fidell (1983) who see 200 respondents as good enough for most purposes, particularly when subjects are homogeneous. According to Roscoe (1975), sample sizes larger than 30 and fewer than 500 are appropriate for most research. Kline (1998) maintained that sample sizes fewer than 100 should be considered small, between 100 and 200 should be considered medium and over 200 should be considered large. In this study, a total of 561 questionnaires were sent out. A total of 232 questionnaires were returned and accepted as valid.

5.6.4.3 Response rate

The response rate is usually influenced by several factors, ranging from the nature of the topic and the sample, the length of the questionnaire and the manner in which the particular survey is conducted (DeVaus, 1996; Remenyi, 2000). The timing of the questionnaire is another important factor that influences the response rate for a survey. This survey questionnaire was made at a time when respondents were presumed to be available and the researcher sent the final questionnaire when the majority of respondents were on duty and not on vacation. Some questionnaires were distributed and collected with the help of colleagues in the same organisations in the three countries. The last questionnaires were collected on 15 Aug. 2009 after several reminders and recalls. Delay was caused by some respondents' loss of questionnaires, so additional copies had to be distributed.

The researcher raised the response rate by a series of follow-up telephone calls and a reminder e-mail. A follow-up was sent two weeks after the first distribution to inform respondents that the researcher had still not received their returned questionnaires. Table 5.2 and Figure 5.3 show the number of questionnaires distributed, the number of valid questionnaires returned and the response rate classified by hand and e-mail for all the three countries' organisations responding. Based on the percentages, the response rate of this research could be regarded as excellent. For details, see Appendix E.

Table 5.2: Percentage of questionnaire responses

	Saudi Arabia			Egypt			UAE			Overall		
	No. of Distributed	*No. of Returned and Valid*	*% of Returned and Valid*	*No. of Distributed*	*No. of Returned and Valid*	*% of Returned and Valid*	*No. of Distributed*	*No. of Returned and Valid*	*% of Returned and Valid*	*No. of Distributed*	*No. of Returned and Valid*	*% of Returned and Valid*
By hand	83	51	61.45	90	48	53.33	55	31	56.36	228	130	57.02
E-mail	147	46	31.29	98	24	24.29	88	32	36.36	333	102	30.63
By hand & E-mail	230	97	42.17	188	72	38.30	143	63	44.06	561	232	41.35

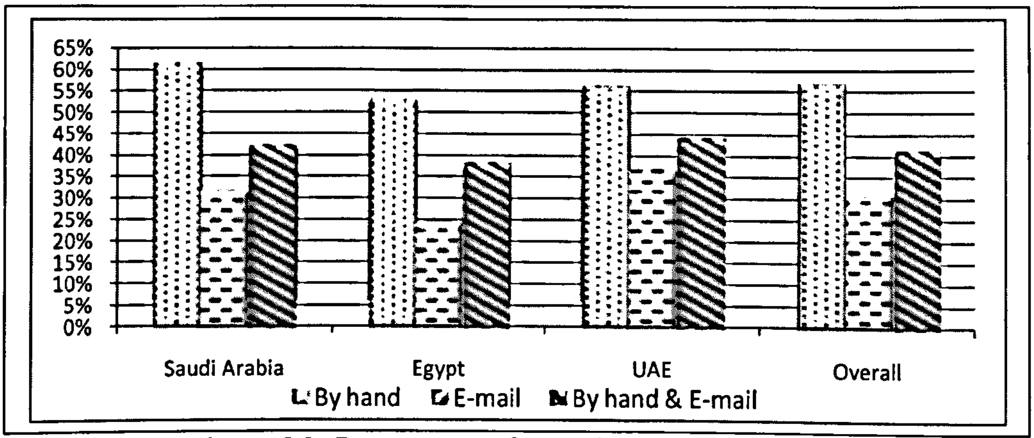


Figure 5.3: Percentage of questionnaire responses

A total of 232 valid questionnaires were returned with a 41.35% response rate (57.02% by hand and 30.63% by e-mails). The highest percentage response came from the UAE organisations, 44.06% (63 questionnaires). The second highest was from the Saudi organisations, 42.17% (97 questionnaires). The lowest response was from the Egyptian organisations, 38.30% (72 questionnaires).

5.7 Data Collection

After determining the most suitable research strategy and research approach, it is necessary to decide how the empirical data will be collected (Robson, 2002). Yet before deciding the most appropriate methods, it is vital to distinguish between two main types of data, namely secondary and primary data.

5.7.1 Secondary Data

Secondary data are the data already gathered by other researchers with different purposes in mind. However, these data provide necessary background information and build credibility for the research report. In addition, they help to clarify or redefine the problem during the exploratory research process. Moreover, they provide a solution to the problem and an alternative to primary data research methods (Remenyi *et al.*, 2000). Secondary data are usually historical, already assembled and not requiring access to respondents or subjects. The related literature review provides results of other studies related to the current study, filling the gap and extending prior study and this is also a framework for establishing the importance of the study

(Brewer and Hunter, 1989). With regard to that, the researcher began this current study by comprehensively reviewing related literature on Six Sigma implementation.

There are a number of methodological advantages to using previously collected data, such as an opportunity for replication, longitudinal research design, measurement of clear variables and an increased sample size (Nachmias and Nachmias, 2000). Both Ghauri *et al.* (1995) and Churchill (1999) argued that the most obvious advantages of secondary data are the savings in time and money. The latter adds that secondary data sources enable the researcher to compare the different research methods in order to select the most appropriate for collecting primary data. However, there are some disadvantages to secondary data, such as that they were not designed especially to meet the researcher's need. Consequently, the researcher must test secondary data for accuracy, bias and soundness (Zikmund, 2003). In addition, Trochim (2001) claimed that disadvantages of secondary data are lack of availability, lack of relevance, inaccuracy and insufficiency.

Secondary data resources are important in data collection (Remenyi *et al.*, 2000; Punch, 2005). For this research, the secondary data used in this research were collected for the literature review to gain more in-depth understanding of the concepts of Six Sigma and to look for an appropriate model for its implementation. The secondary data used in this study were gained from many reference sources, including articles in international journals on quality and Six Sigma and academic electronic journals, such as Emerald and Proquest. In addition, conference proceedings, reports, textbooks, theses, dissertations, unpublished manuscripts, statistics and the Worldwide Web (Internet). By this means, the study has achieved two essential purposes: firstly, to verify from the earlier studies those related to the current one; secondly, to link it with the most recent studies in the same field. Secondary data were used in this study to explore the research questions and meet the proposed objectives.

5.7.2 Primary Data

Primary data are data that a researcher gathers on his/her own with a specific purpose in mind. Ghauri *et al.* (1995) argued that when secondary data are not sufficient to answer the research questions, the researcher should collect primary data. Primary data are the first hand data collected by the researcher. There is no single best way of collecting primary data; they can be collected in more than one way. The method chosen depends on the nature, goals of the study and the characteristics of its elements (Sekaran, 2003). The aim of all methods is to obtain data which are valid and reliable (Remenyi *et al.,* 2000; Robson, 2002). The main methods of collecting the primary data used in the present study were a survey questionnaire and a semi-structured interview.

5.7.2.1 Procedures for obtaining permission for access and study

The researcher was successful in securing access for questionnaire and interview purposes to most organisations in the three countries' organisations implementing or having already implemented the Six Sigma programme, at the study time, from both the manufacturing and services sectors and from both the large organisations and SMEs, through preparation of the participants and the interviewees.

A lengthy procedure including letters was followed to obtain permission for the study in the organisations selected. The researcher obtained different letters from his supervisor, the university and a letter from the Saudi Cultural Bureau, the researcher's sponsor, asking for permission for him to go to the selected organisations to conduct/get to the fieldwork and asking organisations to assist the researcher in collecting the information needed for the study and emphasising his academic purpose to ensure distribution of the questionnaire and to indicate the purpose of the research and assure confidentiality of the information.

Then, some top management and most Six Sigma certified/qualified people were invited to participate in both the questionnaire and the interview parts of the study. A continuous personal contact was made with some of the top management in these organisations as well as most Six Sigma certified/qualified people working in them. Each top management and all Six Sigma certified/qualified people received a questionnaire from the researcher, were informed of the nature of the study and were advised that all responses would be kept confidential. It was thought that this would encourage all participants to be as honest and forthright as possible.

5.7.2.2 *Questionnaire*

5.7.2.2.1 Questionnaire: definition and aim

A questionnaire is a highly structured data collection technique in which respondents are usually asked the same set of questions and it is probably one of the most popular and widely used instruments among researchers. It provides a very convenient and efficient way of collecting responses from a large sample (Saunders *et al.*, 2003) and is extremely efficient in providing large amounts of data in a short time at relatively low cost in terms of time and money, if it is designed and administered properly. Sekaran (2003) defined the questionnaire as a preformatted, written set of questions to which respondents record their answers, usually with rather closely defined alternatives. In addition, he pointed out that a questionnaire is an efficient data-collection instrument when the researcher knows exactly what type of information is required and how to measure it. A questionnaire, as defined by McDaniel and Gates (2002), is a set of questions designed to generate the evidence necessary to accomplish the objectives of the research study.

The purpose of a questionnaire is to collect primary data gathered and assembled specifically for the research project at hand. The questionnaire must translate the research objectives into specific questions (Nachmias and Nachmias, 2000), therefore the researcher needs to clarify the objectives of the research and then decide which questions need to be asked to achieve those objectives.

The questionnaire, like other data collection techniques, has advantages and disadvantages. According to Neuman (2004), it is the cheapest way of collecting data, if chosen, by a single researcher. Another advantage of the questionnaire is that the respondents can complete the questionnaire when it is convenient and can check personal records if necessary. These advantages were critical for the purpose of this research since the other types were costly and time consuming and would result in difficulties in data analysis.

In contrast to these advantages, there are also a number of disadvantages: no control over who responds to the study, response rates are usually low (according to Bourque and Fielder (1995), usual rate is no better than 15-20%) with consequent bias, unsuitability for respondents with poor literacy and often for people with language difficulties, require simple, easily understood questions and instructions, no opportunity to correct misunderstandings or to probe or to offer explanation or help, no control over the order in which questions are answered, no check on incomplete responses, incomplete questionnaires or the passing on of questionnaires to others, missing data, questions needing to be brief and simple, impossibility to check seriousness or honesty of answers, respondents having difficulty with reading, development is often poor and questions may be ambiguous (Nachmias and Nachmias, 2000; Sekaran, 2003; Neuman, 2004.

However, in this study, several steps were taken to minimise the questionnaire disadvantages. The researcher arranged questionnaire questions logically by topic, made a pilot study to produce an error-free version, made the questionnaire as attractive and as easy to complete as possible, included cover letters addressed to the respondents and made follow-up phone calls and e-mailings. These methods are believed to minimise the disadvantages of the questionnaire.

5.7.2.2.2 Questionnaire: design, construction and preparation

Based on an extensive review of the literature on Six Sigma and its implementation, the researcher created a standardised questionnaire to collect data from targeted organisations in the Middle East in order to extract their experiences and get information regarding their Six Sigma implementation. In this study, the researcher did his best to design an attractive and neat questionnaire with appropriate introduction and a well-arrayed set of items in order to make it easier for the respondents to answer them. A good introduction, well-organised instructions and neat alignment of the questions are important (Sekaran, 2003).

For an effective questionnaire, the researcher gave attention to some recommendations:

- Each question should be relevant and useful.
- Each question or statement should be written as clearly and as concisely as possible.

- Qualitative terms that may be understand in different ways, such as 'good', 'bad', 'seldom', 'often' or 'frequently' should be avoided.
- When choices are offered, they should be simple and easy to make.
- Questions should be asked in such a way that the respondent would not find them offensive or objectionable.
- Items should be phrased to elicit the required depth of response.
- Only enough items should be included to cover all of the important areas of inquiry.
- Grammar and spelling should be corrected.
- Items should be stated in such a way as to avoid biased responses.
- Key words in questions should be underlined.

The researcher met the objectives of the research when he designed the questionnaire to obtain the maximum accurate information and accomplish that within the available time and with the resources at hand. Furthermore, he tried to structure the questions carefully in order to achieve objectives and eliminate any bias (Hussey and Hussey, 2003). The researcher was also concerned with the use of proper wording and used simple common language and short questions (Churchill, 1999).

The questionnaire must be able to motivate the respondents to answer. A badly designed questionnaire will discourage them from answering, which might lead them not to answer or provide inaccurate information and the questions must motivate respondents to provide the information being sought. The major considerations in formulating questions are the content, structure, format and sequence. Hence, it is important that the measurement process when applied repeatedly produces consistent results.

When the researcher designed the questionnaire, great attention was given to the questions: they had to be short, interesting, direct, free of grammatical errors and spelling mistakes, without jargon on abbreviations, clear and comfortable for discussion to ensure getting the right data and to avoid any harm to the participants, and some modification were made to ensure simplicity of sentence structure. The researcher also tried to avoid negative questions and questions that might have two meanings or lead to non-specific answers (ambiguous). Besides that, the order and flow of the questions were considered to get a logical sequence which would help in collecting the data.

In this research, the questionnaire has two types of questions. First, closed-ended, requiring respondents to choose from a list of answers. The closed-ended question format was selected since the data would be in a quantifiable form suitable for statistical analysis. Moreover, it was fast and easy to complete, enabled automated data entry and facilitated data analysis and summary of data (Saunders *et al.*, 2003). Each group of questions was preceded by an instructional statement explaining what was required and the meaning of each scale point used to give answers to questions. The questions themselves were designed in closed-ended format, where answers were particularly limited to a number of responses. Second, scaled response, closed-ended questions in which the response selected is measured on a rating scale (five-point Likert scale) which scales the intensity of responses (Likert, 1932; Babbie, 2004) in the presentation of some of the statements. The rating scale allows respondents to indicate the relative importance of choices and this facilitates the researcher's identification of critical issues. In the researcher's view, this made the questions easy to answer and respondents were enabled to choose between ranges of values to give their replies.

The final research questionnaire consisted of nine sections, including the comment section, and contained 25 questions (Appendix A). Each section had a separate and clear title, the questions were designed as indicated above to be straightforward, consistent with the goals of the study, concise and carefully worded and several revisions were carried out to ensure clarity. Furthermore, this was to ensure that the questionnaire covered all important aspects and would give answers to the research questions and that it was easily administered and easily understood, thus making it easy for the respondent to answer. The questionnaire was compressed into six pages. At the beginning of the first page the instructional section contained short statements explaining the purpose of the study, the principles that it was based on and an assurance of anonymity to the responding individual and organisation.

In order to encourage participation in the survey, several measures were taken. First, an introductory letter was enclosed with every questionnaire explaining the study, the researcher's interests, the aims of the study, the importance of the data collected, as well as assuring the confidentiality of respondent identity. Second, the researcher promised to provide an executive summary of the results. The following were some points taken into account for questionnaire design:

- *Questionnaire covering letter*

Each questionnaire began with a title, a concise description of what the study was about. To extract real answers and obtain the confidence of the respondent, the research questionnaire was entitled:

Six Sigma Implementation in Middle East Organisations - An Empirical Study

The questionnaire cover letter (Appendix A) referred to the issue of confidentiality:

It should be noted that all responses and information collected will be treated in the strictest confidence and will be used only for the purpose of the study. No organisation or individual will be named in any ensuing publication.

Each respondent was instructed how to complete the questionnaire:

- *Please tick in the appropriate box.*
- In the case of questions asking the respondent to choose the level of consideration for suggested aspects, the stem was:

To what extent do you consider the following.........?

- *End of Questionnaire*

In order to provide an opportunity for the respondent to write any opinions or suggestions, a blank space was provided and labelled: *Any other comments.* Before the conclusion of each questionnaire, an expression of gratitude was made as follows:

Thank you for your time, valuable input and kind cooperation

5.7.2.2.3 Questionnaire: pilot study

Prior to distributing the finalised questionnaire, a pilot study (pre-testing) needs to be completed. The purpose of this is to discover errors, ambiguities, inadequate response alternatives and confusing questions and to refine the questionnaire and remove any leftover difficulties. It is also to detect possible shortcomings in the design and administration of the questionnaire (Emory and Cooper, 1991) and to ensure that it is perfectly understandable and suitable for collecting the desired data. A pilot study is an essential guarantee that the information offered in the answers has exhausted all possibilities. A pilot study aims to get feedback on whether the questions are comprehensible, the instructions are followed correctly, how long the questionnaire takes to answer and whether there are any other unexpected problems Neuman (2004). McDaniel and Gates (2002) defined the pilot study as a survey using a limited number of respondents and often employing less rigorous sampling techniques than in large, quantitative studies. As Bell (2005) pointed out, the pilot study is the most inexpensive insurance the researcher can adopt to ensure the success of the questionnaire and the research project. A careful pilot study should make the questionnaire development process successful.

Neuman (2004) argued that by using pilot tests, the researcher increases the reliability of measures. There are several purposes of the pilot study. First, responses can help make sure the instructions are clear, the wording of additional items is appropriate and the time to complete the survey is acceptable. Second, to ensure the validity and reliability of a certain measure. Third, the use of a pilot study is essential, where the draft questionnaire is tested on a small group of people who have the same characteristics as the sample group to be used for the main. Fourth, as suggested by Gill and Johnson (2001), to help gauge how respondents would interpret and react, to allow any necessary changes to be made. Bell (2005) had a list of questions to ask those involved in a pilot study:

- How long did the questionnaire take you to complete?
- Are the instructions clear enough?
- Which, if any, questions are unclear or ambiguous?
- Which, if any, questions did you feel uneasy about answering?
- What is the validity and consistency of the questionnaire?
- Are there, in your opinion, any significant topic omissions?
- Will you please add any comments or suggestions?

In this study, the purpose of the pilot study for the questionnaire and the semi-structured interview was to ensure that they were clear and concise and that the measurement items revealed their intended meaning and to assess time required to complete them. The pilot was done before the empirical study to test the validity and reliability of the issues. A pilot study for the questionnaire and the semi-structured interview was conducted in English. Four organisations were used with two Six Sigma persons from each organisation completing the questionnaire and semi-structured interview. In addition, two other individuals serving in academic positions in universities were asked to complete the questionnaire and semi-structured interview. The respondents' opinions with regard to the wording of the questions, the difficulty in completing the questions and the time required to complete the questionnaire, were solicited. The respondents were observed to complete the instrument without confusion or need for clarification. They were asked to provide feedback on the overall design, particularly the measurement scales, as well as their overall reaction to the survey based on their experience and on the format as well as the clarity and consistency of questions. Their feedback was collected verbally face-to-face and by phone calls or e-mail. This feedback was then considered by making necessary adjustments to improve the design and clarity of some questions and several modifications were thus made to the wording and scaling of certain ones. The instrument was also seen as lengthy and, as a result, several questions found not to be directly addressing the issues under study were dropped. A final version was agreed and the green light was given to launch the study (Appendix A). Then the questionnaire was prepared and printed with an appropriate covering letter and distributed to the study sample.

5.7.2.2.4 Questionnaire: distribution

Once the target sample had expressed interest in participating, questionnaires were handed out personally or sent by e-mail. The main advantage of personally administered questionnaires is suitability for cases where participating organisations are in proximity to each other and targeted informants can be conveniently assembled in the organisations' conference (or other) rooms to complete the questionnaires under supervision, to ensure that all questions could be answered. On the other hand, an e-mail's advantage is that a wide geographical area can be covered in the survey (Sekaran, 2003).

Most of the questionnaires were handed to the potential respondents in person. The reason for that was to explain the objectives of the research and the purpose of the questionnaire and to make sure that the contents of the questionnaires were clear. The researcher was in contact with those respondents for co-ordination in case of any difficulties in answering the questions. After four weeks, responses were seen to be low. Therefore, after a follow-up reminder telephone call, copies were sent again with mention of the personal name for each. Furthermore, in order to increase the response rate, the researcher phoned the non-participants and sent questionnaires again by e-mail to the respondents who preferred this.

5.7.2.2.5 Questionnaire: language consideration

The choice of appropriate language was important to ensure that the respondents were able to answer the questionnaire based on their understanding and experience. Since English is the common international business language used in the three selected countries, respondents would have no difficulty in understanding terminology and other technical terms because all were fluent in English. So English language was used throughout the questionnaire for all respondents in the three countries. This was an added advantage, as only one language was used throughout the study instead of translating the questionnaire into other languages which would have been time consuming and errors could have occurred in translation. Consequently, the use of English was more convenient for all respondents to understand and complete the questionnaire.

5.7.2.3 Interview

Many kinds of social science enquiry now use interviews as a method of serious data collection. Thus, the interview is one method for the collection of data to be used in research and is considered as one of the most widely used procedures in social researches. However, what exactly is interview?

5.7.2.3.1 Interview: definition and aim

Hussey and Hussey (2003) defined interview as "A method of collecting data in which selected participants are asked questions in order to find out what they do, think or feel". Also, Robson (2002) defined interview more precisely as "A purposeful conversation in which one person (the interviewer) asks prepared questions and another answers them (the respondent). It is a directed conversation, the purpose of which is to gather information by means of administering the same set of questions in a consistent way to all selected respondents. These respondents presumably are representative of population of the interest or the target population". In addition, Zikmund (2003) stated that an interview is a survey method that gathers information through face-to-face contact with individuals.

In this research, the objective behind the interviews was to collect as much in-depth information as possible on the implementation of Six Sigma in the three Middle East countries, Saudi Arabia, Egypt and UAE. Interviews were used in triangulation to test the extent to which there was validity in the responses provided in the questionnaire. The interviews were semi-structured, with a limited choice of imposed responses with a list of prearranged questions, and were held with top managers and certified/qualified Six Sigma people in the organisations considered in the sample. The use of interview as a complementary mode of enquiry was a way of compensating for questionnaire disadvantages.

The semi-structured interviews in this study had three main purposes: for comparison with the data from the research questionnaires, triangulation and additional information and views which could not be gained through the questionnaires. Semi-structure interviews were carried out in the three countries. The target interviewees were the top management and the Six Sigma certified/qualified people in the responding organisations.

The use of semi-structured interviews is associated with survey research. This method relies on the use of a questionnaire as the data collection instrument. The theory behind this method is that each person is asked the same question in the same way, so that any differences between answers are held to be real ones and not results of the interview situation itself. This method is also increasingly popular in telephone interviews.

Interviews are a low-cost, rapid method for gathering information from individuals or small groups. These interviews partially use a written interview guide, thus the interview will focus on the issue at hand, whilst allowing participants to introduce issues they deem to be relevant. Both Hussey and Hussey (2003) and May (1997) suggested that an interview should use a minimum number of questions to focus the interview, allow for conversational flexibility and enable the researcher to become familiar with the subject area. Familiarity with the interview guide is critical for the interview to be conducted in a conversational way. So, the semi-structured interview is the possible type of interview for this research. Semi-structured interviews may be used in relation to an exploratory study, as argued by Saunders *et al.* (2003), and for that reason are used in this research. In addition, they help to obtain answers needed to the how and why questions.

Despite the flexibility of semi-structured interviews, there are difficulties associated with the process. It can be time-consuming and expensive in resources. Moreover, interviewees may have certain expectations about the interview and give what they consider to be a correct acceptable response to questioning. Despite this, interviews allow the researcher to ask complex questions with 'follow-up', which may not be possible in other forms of data collection. In keeping with the triangulation research methodology, the interviews would be used to corroborate findings established by the study questionnaires.

As with other methods, there are advantages and disadvantages to personal interviews. According to Oppenheim (1996), Nachmias and Nachmias (2000), Robson (2002) and Saunders (2003), advantages include:

- Provide and give greater freedom to respondents to express themselves, thereby eliciting a rich database.
- Allow some control over them and ensure the high response rate.
- Offer greater opportunities for clarifying the purpose of the study more convincingly, to clarify issues and avoid any misunderstandings related to the questions or concepts used.
- Offer a flexible method allowing some freedom to adjust or modify the questions to suit the situation, to clarify unclear questions, clarify doubts and rearrange the order of questions. This means that unlike other methods, the interview gives the chance to probe for more information in areas of interest that may emerge during the interview, whereas other methods, such as the questionnaire, for example, are confined to the set questions.

- Reveal new insights, identify general patterns and understand relationships between variables.
- Give flexibility in the question process: interviews can range from highly semi-structured to non-structured, depending on the research problem under examination. In focused and non-directive interviews, the interviewer can clarify questions and probe for additional information.
- Give flexibility to clarify unclear questions, clear doubts and rearrange the order of questions.
- Produce a high response rate.
- Allow collection of additional information.
- Potentially high cost, especially if the population covered is dispersed geographically. Possibly time-consuming and resource-intensive from the preparation stage to the conclusion of the process.
- Interviewer bias. Innate characteristics of interviewers and differences in interviewer techniques may affect respondents' answers.
- Lack of anonymity. Presence of the interviewer may make the respondent feel threatened or intimidated.

On the other hand, Robson (2002) and Saunders (2003) pointed out the disadvantages of using personal interviews, some of which are higher cost, the interviewer's personal influence and bias could affect the interview and the interview lacks the anonymity of the mail questionnaire.

5.7.2.3.2 Interview: design, construction and preparation

The first step was to ensure the willingness of the target sample to participate and cooperate in sharing their knowledge and experience. This was done by informing them by e-mail of the intention to conduct this research survey four weeks before the questionnaire was sent to them. They then had to reply by e-mail as to whether they were willing to participate in the survey. Follow-up phone calls were made to arrange for initial interviews.

Interviews usually permit the interviewer's personal influence and bias to intrude and may minimise the ability to maintain anonymity, which can be particularly important when sensitive issues are being researched. They are often preferable to survey questionnaires because of the role the interviewer can play in enhancing respondent participation, guiding the questioning, answering the respondents' questions and clarifying the meaning of responses (Nachmias and Nachmias, 2000; Hussey and Hussey, 2003). In addition, according to Robson (2002), interview samples are systematically determined and selected respondents are not in a position to throw away the questionnaire. Once contacted, they are more likely to participate in survey interview.

In this study, the researcher needed to establish a relationship with the respondents and motivate them to give responses relatively free from bias by allaying whatever suspicions, fears, anxieties and concerns they may have had about the research and its consequences. The researcher must be truthful, pleasant and non-evaluative. According to Sekaran (2003), the researcher must ask broad questions and then narrow them to specific areas, ask questions in an unbiased way and clarify them and help respondents to think through difficult issues. The researcher must write or record responses immediately; they should not be entrusted to memory and later recalled.

5.7.2.3.3 Interview: implementation

As mentioned before, in selecting the organisations to take part in the interviews, only those which had already implemented or were currently implementing Six Sigma projects were selected. The reason for the selection was to explore and investigate the situation of Six Sigma implementation in the Middle East. This research implemented semi-structured interviews intended to allow interviewees to reveal their perceptions about the Six Sigma implementation without being limited to some specific areas. On the other hand, semi-structured interviews steer interviewees in the right direction to answer the research questions without diminishing their ability to talk about some areas they think might be of interest.

All interviews were conducted between mid-2008 and mid-2009. The interviewees included in this research came from different aspects as well as practical backgrounds and had good information on or qualification in the Six Sigma concept.

Most respondents to the survey questionnaire were willing to take part in the interviews. One hundred and forty-five respondents completing the survey questionnaire had originally indicated (as requested in the last page of the survey questionnaire) their willingness to participate in the interview. But only 74 completed interviews are incorporated into this analysis (25 from Saudi Arabia, 26 from Egypt and 23 from UAE). The number of interviews, 74, was satisfactory. Table 5.3 and Figure 5.4 show the 74 interviewees and their corresponding position within their organisations.

Table 5.3: Number and position of interviewees

Interviewees' Position	Saudi Arabia	Egypt	UAE	**Overall**
Top Management (CEO and Senior Managers)	5	5	4	**14**
Quality Manager	1	3	2	**6**
Champion	3	2	1	**6**
Master Black Belt	3	2	2	**7**
Black Belt	9	8	8	**25**
Green Belt	4	6	6	**16**
Total	**25**	**26**	**23**	**74**

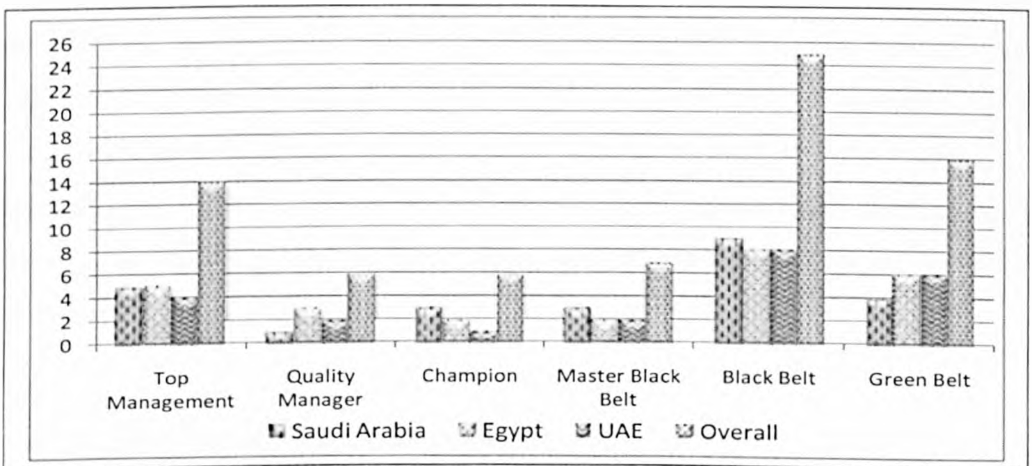


Figure 5.4: Number and position of interviewees

The interview questions were similar to that of the questionnaire to assess personal opinions and 25 questions to present a profile of interviewees' organisations, interviewees, Six Sigma programme and Six Sigma implementation in the organisations. In addition, to determine the reasons for/ benefits of Six Sigma implementation, to determine the main challenges faced in Six Sigma implementation and determining the CSFs for effective implementation of Six Sigma. The final question concerned obtaining the view of interviewees' organisations on their level of satisfaction with the results achieved through the Six

Sigma programme implementation in their organisations in the Middle East. The interview questions are listed in Appendix B.

In each interview, the researcher started by introducing himself, describing the purpose of the study and emphasising to interviewees that their responses would be kept confidential and used only for the purpose of the research. Interviews were done individually and not in groups. Some respondents preferred reading the interview questions and writing their comments on them. However, follow-up phone calls were made to cover some aspects not fully dealt with in the interview.

In this research, all interviews were face-to-face for Saudi Arabia and by phone for Egypt and UAE. Each interviewee was reminded by phone prior to the interview of the scheduled date and time. Organisations, respondents and participants interviewees were assured of their anonymity. At the beginning of each interview, this assurance was reiterated. The actual time taken for each interview ranged from approximately 30 to 45 minutes. Interviewees were excited about the relevant issues under consideration. Most, if not all, interviews were not recorded and most interviewees were in fact not willing to allow recording, even with the assurance of confidentiality of data. At the same time, the chance was given to the interviewees to comment on how the Six Sigma project was implemented and the processes involved.

5.7.2.3.4 Interview: language considerations

The majority of the interviews were in English as some interviewees were non-Arabic speakers. Note-taking was done throughout all interviews in order to document as much data as possible. The researcher rewrote and expanded these notes immediately (in an appropriate setting) upon completion of interviews.

5.8 Data Analysis

Data analysis is the process whereby researchers enter the raw data into a data matrix and create information that can be used in achieving the objectives for which the research was undertaken. During the research design stage, researchers should have decided how to analyse the data. Unfortunately, many researchers wait until the analysis stage to decide what to do. Some results of this are that some data will not be collected, will be collected in the wrong form or will exhibit unanticipated characteristics. According to Nachmias and Nachmias (2000), after collecting the data, researchers must undertake several steps in order to obtain meaningful results from the analysis stage. These steps include data editing, handling blank responses, coding, data entry and data analysis. The following sub-sections will discuss these steps in more detail.

5.8.1 Editing Data

The first step in data analysis is to edit the raw data. When data come from questionnaires and interviews, editing becomes an essential step. Editing detects errors and omissions, corrects them where possible and certifies that minimum data quality standards are achieved. Cooper and Emory (1995) believed that the central idea of data editing is to assure that data are accurate, consistent with other information, uniformly entered, complete and arranged to simplify coding and tabulation. However, the researcher should be aware of any unjustified editing that can introduce a bias in the data, thus affecting the results of the study.

In this study, every questionnaire received was dated and read thoroughly by the researcher. Answers were reviewed and checked for accuracy, completion and consistency. Detected errors or suspicious answers, if found, were highlighted and a note made alongside. If a proper answer could be reached by reading other information in the survey tool, editing was done. At interviews, the researcher edited the data manually so that all were systematically categorised and inconsistencies noted in the responses were logically rectified at this stage. In addition, respondents' comments and points of view, gained through the questionnaires and interviews, were edited and coded so that they would fit the purpose of the research.

5.8.2 Managing Blank Responses (Missing Data)

The researcher should expect missing data (left blank) in some questions of a questionnaire as well as interview, as some respondents do not answer every question because of not understanding the question, not being willing to answer or simply not being interested enough to respond to the entire questionnaire or interview. In the literature, many techniques for handling blank responses are suggested. A way to deal with a blank response to an interval-scaled item with a midpoint would be to assign that point for that particular item. Another way is to allow the computer to ignore the blank responses on analysis (Sekaran, 2003). The latter technique was probably the best way to handle missing data to enhance the validity of this study, especially as the sample size is big.

5.8.3 Coding, Categories and Data Entry

The core and central tool of any analysis is its system of coding and categories. Coding is the technical procedure by which data are categorised and the process of grouping respondents' and interviewees' responses into categories that bring together similar ideas, concepts and themes discovered or steps or stages in a process. Every unit of analysis must be coded, that is to say, allocated to one or more categories. Coding involves assigning numbers or other symbols to answers, so the responses can be grouped into a limited number of classes or categories. This helps the researcher to reduce several thousand replies to a few categories containing the critical information needed for analysis. Letters, numbers or a combination of both can be used for coding. In coding, categories are the partitioning of a set.

In this study, each questionnaire received was first checked for errors and omissions, then answers were entered manually into the computer and the data became ready for analysis. The entry process was a good and difficult experience because it involved 232 questionnaires. The study variables were coded by being given unique labels. All completed surveys were allocated a code (Saudi Arabia: S-A, S-B, S-C, ..., Egypt: E-A, E-B, E-C, ..., and UAE: U-A, U-B, U-C, ...) that could be used to identify the responding organisations and their respondents and interviewees for analysing the results and to ensure anonymity for all of them (see Appendix E). Once coded, all data from the questionnaire were entered into a data analysis programme for the SPSS (Statistical Package for the Social Sciences) (version 16) used in data analysis. This step helped in setting up the computer software to analyse the data. So the researcher was very careful at this stage to avoid the mistakes that may occur.

5.8.4 *Purification of Measures*

After the entry and coding processes had been completed, all measures were then purified by assessing their reliability and validity. There are a number of reasons for the emphasis on the validity and reliability of the measurements. First, a reliable and valid measuring instrument enhances the methodological rigour of the research. Second, it permits a co-operative research effort and provides support for triangulation of results. Third, it provides a more meaningful explanation of the phenomena being investigated.

5.8.5 *Statistical Data Analysis Techniques*

This research has used different techniques for analysing the data collected from the fieldwork considered suitable for this study:

- ***Descriptive statistical analysis***

Descriptive statistics is a part of the statistics family that deals with organising and summarising possibly large collections of experimental measurements in order to obtain one or more meaningful values that summarise the major characteristics of the data (Nachmias and Nachmias, 2000). Descriptive statistics were used to describe the data obtained, investigate the sample and give a good picture of its characteristics to help the researcher in answering the research question.

In this study, the researcher has used some statistics such as descriptive measures (mean and standard deviation, frequencies, percentages, ranking, mean rank and *P* significance). These descriptive statistics measures are used here for reporting the characteristics of the surveyed organisations and simultaneously providing adequate statistical support to the findings.

- ***Significant difference analysis tests***

The following are the non-parametric statistical tests for significant difference analysis used in this study. The researcher used these tests to examine the associations between research variables, then to take account of the nature of the research variables and the data set and to check if there is a significant difference between the sets of scores.

- *Mann-Whitney U Test:* The Mann-Whitney U test is a non-parametric test for assessing whether two independent samples of observations come from the same distribution. It is one of the best-known non-parametric significance tests and virtually identical to performing an ordinary parametric two-sample t test on the data after ranking over the combined samples. This is an equivalent to the t test and tests whether two independent samples are from the same population. It is more powerful than the median test since it uses the ranks of the cases. It requires an ordinal level of measurement. The test is used to get the degree of significance of the gap between the important issues and their respective implementation.

- *Kruskal-Wallis Test*: Kruskal-Wallis test is used with non-parametric data and is similar to regression in that it is used to investigate the relationship between a response variable and one or more independent variables. The Kruskal-Wallis one-way analysis of variance by ranks is a method for testing equality of population medians among groups. It is an extension of the Mann-Whitney U test used to observe whether there are significant differences between three or more groups and in which rank order the groups fall.

- *Friedman Test*: It is a non-parametric statistical test used to detect differences in treatments across multiple test attempts. The procedure involves ranking each row together, then considering the values of ranks by columns.

- ***Correlation analysis***

As previously stated, one of the main objectives of the questionnaire was to assess the effectiveness of Six Sigma main elements in successful Six Sigma project implementation. To determine the relationship between main factors (independent variables) and satisfaction with successful implementation (dependent variable) and to investigate the effects of the independent variables on the dependent variable, correlations were used.

The correlations analysis was selected because the objective was to observe whether there were significant correlations between sets of two variables and whether these correlations were in the direction predicted. The test will reveal the correlation between the variables in the model. Measures of correlation indicate the strength and the direction of the linear relationship between a pair of variables. All the independent variables and subjective dependent variables for the study were submitted for correlation coefficient bivariate analysis. The correlations can range from -1.00 to +1.00, and indicate the strength of the relation between the two values (Pallant, 2007).

Correlation coefficients measure how variables or rank orders are related. The main reasons that led the researcher to choose correlation are that it will illustrate the relationship between the variables that will show the impact of each variable on other variables. It was used to test and reach the research goals by understanding the effect of Six Sigma implementation on Middle East organisations' satisfaction. Correlation is used to validate and test the relationship between all variables in the model. It was used to probe the association between variables that relate to the study variables.

This study computes correlation coefficient and Spearman's rho, with their significance levels. Regarding the significance of correlation, typically, in many sciences, results that yield $P < 0.05$ are considered borderline statistically significant and $P < 0.005$ or $P < 0.001$ levels are often called highly significant (McDaniel and Gates, 2002; Saunders *et al.*, 2003).

In this study, the level of correlation used in this study is based on Cohan (1988) guidelines on degree of relationship as: < 3.0 is small relation, 0.3 - 0.5 is medium relation and > 0.5 is strong relation (Cohan, 1988)). Once the Chi-squared and Z value increases, the significance value increases (linear relationship). More difference, more significance. In addition, the advanced statistical programme SPSS (Statistical Package for the Social Sciences) (version 16) and Microsoft Excel 2007 were the main tools for descriptive data analysis of the research quantitative data.

5.9 Research Measurement Issues: Credibility Testing

The assessing measurement issue is fundamental and central to the success of any truly scientific research work because irrelevant measuring instruments will give the researcher useless information, thus the degree of its reliability and validity must be assessed (Peter, 1981). Both of these are very important in designing the data collection instrument. Whatever procedure for collecting data is selected, it should always be examined critically to assess to what extent it is likely to be valid and reliable. Validity and reliability concerns are evident in any study but are particularly difficult to address in qualitative studies. Because this study combines quantitative and qualitative techniques, care was taken in the design of the study to ensure that validity and reliability were properly addressed during both data collection and data analysis. Thus, before data collection, problems regarding validity and reliability of the research instruments used in the study should be addressed. Those two criteria will be discussed in more detail in the following sub-sections.

5.9.1 Research Reliability

In order for scientific inferences to be valid, one must first determine the reliability of the research instrument. Thus, prior to data analysis, the research instrument was assessed for its reliability in this research. Reliability refers to the stability and consistency with which the instrument is measuring the concept and helps to assess the goodness of a measure (Nunnally and Bernstein, 1994; Cooper and Emory, 1995; Nachmias and Nachmias, 2000; Sekaran, 2003; Yin, 2003). In other words, reliability is the extent to which a test or procedure produces similar results under constant conditions on all occasions (Bell, 2005). Trochim (2001) defined reliability, as in research, as meaning repeatability or consistency. A measure is considered reliable if it would give us the same result repeatedly at different times under different conditions. It concerns the dependability, consistency, accuracy, predictability and stability of a measuring instrument; in addition, reliable instruments are robust when they work well at different times under different conditions. Hussey and Hussey (2003) suggested that reliability is one aspect of the creditability of the findings, the other being validity. Poor reliability can be a result of various sources such as contest instrument items, researcher bias, respondent bias and unreliable subjects.

Reliability analysis allows the researcher to study the properties of measurement scales and the items that make them up. The reliability analysis procedure calculates a number of commonly used measures of scale reliability and also provides information about the relationships between individual items in the scale that determine the extent to which the items in the questionnaire are related to each other. The various procedures in determining reliability cover two aspects, external and internal reliability. External consistency procedures compare cumulative test results with each other as a means of verifying the reliability of the measure. The internal consistency of a set of measurement items refers to the degree to which items in the set are homogeneous. Internal consistency uses only one administration of an instrument or test to assess consistency or homogeneity among the items.

One of the best ways to assess consistency internal reliability is through the use of Cronbach's coefficient α, which is used for multipoint-scaled items (Nunnally, 1978; Cronbach, 1984; Nunnally and Bernstein, 1994; Cooper and Emory, 1995; Churchill, 1999; Sekaran, 2003). Nunnally and Bernstein (1994) recommended that the coefficient alpha should be used as the first test of internal consistency in assessing the reliability of a multiple-item variable. The Cronbach alpha is widely used for estimating the internal consistency and reliability of a measure. It reflects how well each of the items correlates with the entire scale or sub-scale. The size of this coefficient depends on the average correlation among items and the number of items. In other words, the greater the degree of consistency and stability in an instrument, the greater is its reliability. The value of coefficient α typically ranges from 0 to 1 and the nearer the value of α to 1, the better the reliability. If the value is low, either there are too few items or there is very little commonality among them; dropping items that do not contribute significantly to the average correlation can increase the value of α and, in essence, the reliability of the measure. Although some researchers suggest 0.7 as the accepted cut-off (Hair *et al.*, 2002), a value of more than 0.6 is regarded as satisfactory (Nunnally and Bernstein, 1994; Antony *et al.*, 2002). Nunnally (1978) suggested that reliability of 0.5 to 0.6 would be sufficient. However, trying to increase the reliability to more than 0.8 would be a waste of time. Generally, a Cronbach's α of 0.60 or higher is thought to indicate an acceptance level of internal consistency (Black and Porter, 1996). This technique will assess the degree to which the items used in the measure are internally consistent or inter-correlated.

In this study, the reliability measurement is done using the Cronbach's α and the item-to-total correlation. In this process, the item-to-total correlation of each of the items (variables) measured is calculated and analysed. Items found to have low correlation are removed unless they represent an additional domain of interest. This method is considered as the most common procedure used by researchers in guaranteeing the reliability of a multi-item scale (Churchill, 1999). The purpose of the item-to-total correlation measure is that it determines the relationship of a particular item to the rest of the items in that dimension. The process helps to ensure the items making up that dimension share a common core (Churchill, 1999). In this purification process, only those items with item-to-total correlation scores of 0.30 and above are retained for further analysis because they are considered to have high reliability (Churchill, 1999). However, items which fall below this mark are scrutinised before being removed from the dimension. Therefore, the reliability of the scales was tested and Cronbach's alpha was used as the indicator. Cronbach's alpha was also employed and this provides a measure of internal consistency, which reflects how well each of the items correlates with the entire scale or sub-scale.

Moreover, the corrected item-total correlation was used. In other words, this study examined the correlations of each item's score with the total scale score in order to investigate whether the items measured the same construct. This method usually subtracts each item score from the total score to eliminate a false part-whole correlation. Each item's score is then compared with the corrected total score. Although there is no universally agreed cut-off point, the most widely adopted threshold is 0.3 (Nunnally and Bernstein, 1994). Furthermore, if an item has a negative 'corrected item-total correlation coefficient', the item is eliminated from further consideration.

5.9.2 Research Validity

Validity is measured for content and construct of an instrument. The purpose of establishing validity is to assess the quality of correspondence between a theoretically based construct and its operational measures (Babbie, 2004). The validity of a measure is equally as important as its reliability. For Hussey and Hussey (2003), validity is the extent to which the research findings accurately represent what is really happening in a given situation. Consequently, research errors, such as faulty procedures, poor samples and inaccurate measurement, undermine validity. Furthermore, Smith (1981) defined validity as the degree to which the researcher has measured what he has set out to measure. Babbie (2004) wrote that validity refers to the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration. In other words, validity is concerned with whether we are measuring the right concept or not. It is the ability of a research instrument to measure what it is purported to measure (Cooper and Emory, 1995).

Content or face validity is a measure judged subjectively. Several Six Sigma professionals were selected to review the survey instrument to assist in determining the content of the questionnaire and questions covering the domain for which the study is designed. Each of these individuals was interviewed and, as a result, some of the questions were redesigned and some were eliminated. These reviewers made several valid suggestions, which resulted in the addition of some questions that would enhance the questionnaire.

In this study, the researcher believes that validity has been achieved and that the instruments used have a good degree of validity. Several techniques have been used to accomplish such a goal:

1. The study instruments, the questionnaires and the interviews have fully covered the topic of the research. Based on the literature survey in an earlier stage of this study, the important aspects have been brought to light and comprehensively covered in the questionnaire.
2. The questionnaire was tested and revised. Five academics at the Management School, University of Bradford, were asked to give their feedback on it and it was

also given to five doctoral students to make any suggestions concerning clarity of the wording, correct use of specific words, ambiguity, consistency of the questions and overall presentation. Valuable feedback was received and some questions were modified.

3. Personal interviews were held with 74 participants (top managers and Six Sigma certified/qualified people of the 37 organisations). This technique was used as a second data-gathering instrument in triangulation, which contributed to the validity of this study.
4. The interviews were also a validation process for the questionnaire, because it is working as an extended step but sharing the same basic principles and this reflected a strong degree of validity.

5.10 Research Ethical Issues

The ethical issues related to survey research have been discussed by many authors in the literature. According to DeVaus (2002), Smith (2003) and Neuman (2004), the ethical issues related to survey research are informed consent, privacy, confidentiality and no harm, anonymity and voluntary participation. Accordingly, the ethical issues dealt with in this research were informed consent, confidentiality, anonymity and voluntary participation and different actions during different phases of the research in order to meet the ethical issues. The ethical issues of survey research should be covered early in the research design process (Neuman, 2004). The issues can arise at the planning stage or before the research commences, when implementing or during the research and at the reporting stage or after data collection. In this study, the ethical issues of survey research covered the following.

5.10.1 Ethical Issues before Starting Research

- *Access to subjects*: Formal letters concerning this study were signed by the researcher supervisor, the university and the Saudi Arabian Cultural Bureau (the sponsor) and sent with each questionnaire. The letters explained the purpose of the study and asked each targeted organisation to help and cooperate with the researcher. A personal letter from the researcher also accompanied the questionnaire, explaining to them the purpose of the study and its importance. It also urged each of them to participate in completing the questionnaire and to return it as soon as possible. In addition, the researcher used his personal relationships to gain access to the organisational documents needed.

- *Confidentiality of respondents*: Research results were to be presented as summaries of data without reference to each organisation identified only by code in the sampling and sample design phases. On the other hand, all organisations were provided with a summary of the results. When data were entered into the SPSS package, the items were represented only by codes, regardless of who made the analysis; the researcher thus dealt with codes only. In order to protect confidentiality still further, the questionnaires were coded by new codes different from the database ones.

5.10.2 Ethical Issues for Data Collection

- *Confidentiality of respondents*: Each questionnaire was coded by a digit representing the sample items code known only by the researcher in the sample data base and this procedure was explained to the respondents. Furthermore, the questionnaire was returned to the researcher directly. Participants were asked to complete a paper version or an e-mail version (Word document) of the survey questionnaire, comprising an introductory front page and questions. The aims of the study were outlined for the participant on the front page and confidentiality and anonymity were also explained.

- *Voluntary participation*: The researcher stressed the participation in the informed consent and in the covering letter of the questionnaire and that the respondents should not decide to withdrew before reading the questionnaire or if they had any question about the questionnaire content; in these cases, they could contact the researcher in person or by e-mail, for which the researcher put his phone number and e-mail address on the questionnaire.

5.10.3 Ethical Issues for Data Presentation and Reporting

- *Anonymity of respondents*: Sample items (each organisation) were coded; for that reason, the researcher dealt only with codes and the details of the research samples were kept confidential in a secure database.

- *Anonymity and confidentiality*: Related to the above, the researcher can take steps to increase confidence of the respondents that these will not be abused. One such way is that a note should be made that respondents are not required to give their names or any other information that might identify them personally and their responses will be given as strictly confidential and will not be used for anything other than the study. The respondent has a right to know who is conducting the study and why. Therefore, the researcher informed the respondents that the research was for the purpose of completion of a doctorate by the named researcher at the University of Bradford, UK.

Finally, in this study, these issues were taken into serious consideration. This is because research ethics is a challenging subject that the research candidate has to face and, if not addressed correctly, may cause the results of the research to be considered tainted or even invalid (Remenyi *et al.*, 2000). It should be noted that all information gathered in this study is used only for the purpose of the research and treated with the highest level of confidentiality and will not be disseminated to the public and/or competitors.

5.11 Chapter Summary

This chapter has provided and discussed a detailed scenario of the research design and methodology issues that the researcher needed to consider in this study. It started with a brief review of the literature on the available research designs and methods used in the study. The justifications of research design and methodology and the research process are explained. The rationale and the reasons for selecting methods for data collection and the design of data collection instruments are also explained. The methods, procedures undertaken and the analysis techniques used are outlined. Also, the consideration of the selection of the research methodology and the chosen methodology has been justified according to the research objectives. The sampling strategy and the instrumentation created and adopted for this study were briefly introduced and explained. The steps undertaken in the pilot study were demonstrated and the statistical measures undertaken were defined and discussed. In addition, the rationale for choosing the data collection and data analysis techniques has been discussed. The validity and reliability were demonstrated and explained. Finally, a descriptive analysis of the statistical techniques was addressed. The next two chapters (Chapters 6 and 7) will discuss and address analysis of data collected from the questionnaires and the interviews, respectively.

CHAPTER 6

QUANTITATIVE DATA ANALYSIS

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QUANTITATIVE DATA ANALYSIS

6.1 Introduction

This chapter is mainly concerned with the quantitative data analysis of the research survey questionnaire (232 questionnaires - closed ended and rating five-point Likert scaled questions - from 44 Middle East organisations). There are two main parts. The first part (Section 6.2) addresses analysis of the demographic data (characteristics of respondents and their organisations) to give information on the background of the questionnaire respondents and to provide a brief profile of the respondent' samples in the study. Demographic details were initially classified into five sub-sections: respondents' organisations (Section 6.2.1), individual respondents (Section 6.2.2), Six Sigma programme (Section 6.2.3), Six Sigma implementation (Section 6.2.4) and respondents' comments (Section 6.2.5).

The second part (Section 6.3) analyses the key issues of data collected from the survey questionnaire related to the research questions regarding the Six Sigma implementation which are the reasons for/ benefits of Six Sigma implementation (Section 6.3.1), the challenges of implementation (Section 6.3.2), the CSFs for implementation (Section 6.3.3) and the satisfaction with implementation of Six Sigma in the Middle East (Section 6.3.4). The chapter concludes with a summary. Figure 6.1 shows the structure of the chapter.

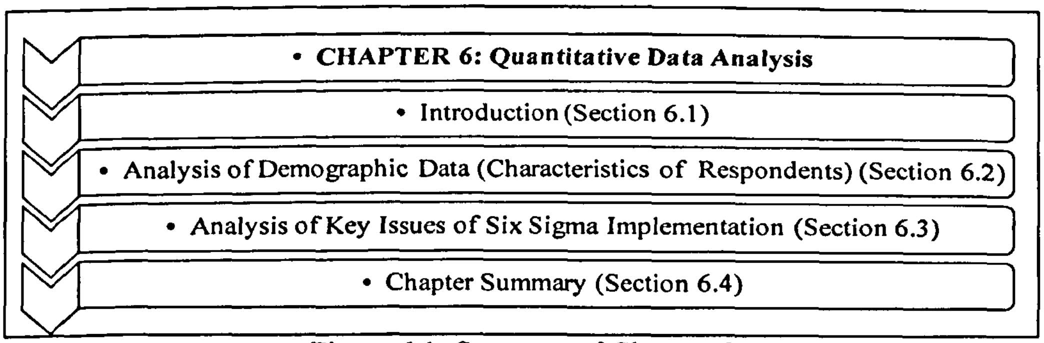


Figure 6.1: Structure of Chapter 6

6.2 Analysis of Demographic Data (Characteristics of Respondents)

The following sub-sections provide a detailed description and analysis of the demographic data (characteristics of respondents and their organisations) from the research questionnaire with the corresponding sections in the questionnaire presented in parenthesis. Full and detailed discussion of the demographic data will be presented in Section 8.2.1.

6.2.1 Profile of Respondents' Organisations (Questionnaire, Section 1)

The aim of this profile is to give information on the background of the respondents' organisations. The descriptive analysis includes organisations' names, location by country, sector and size according to the number of employees and each of these will have a full detailed description and analysis.

6.2.1.1 Names of organisations (Section 1, Question 1)

This optional question was designed to determine whether the respondents' organisations were willing to provide their names for the study or not. Table 6.1 and Figure 6.2 present details.

Table 6.1: Names of respondents' organisations

	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Willing to provide names	12	63.16	8	57.14	9	81.82	**29**	**65.91**
Not willing to provide names	7	36.84	6	42.86	2	18.18	**15**	**34.09**
Total	19		14		11		**44**	

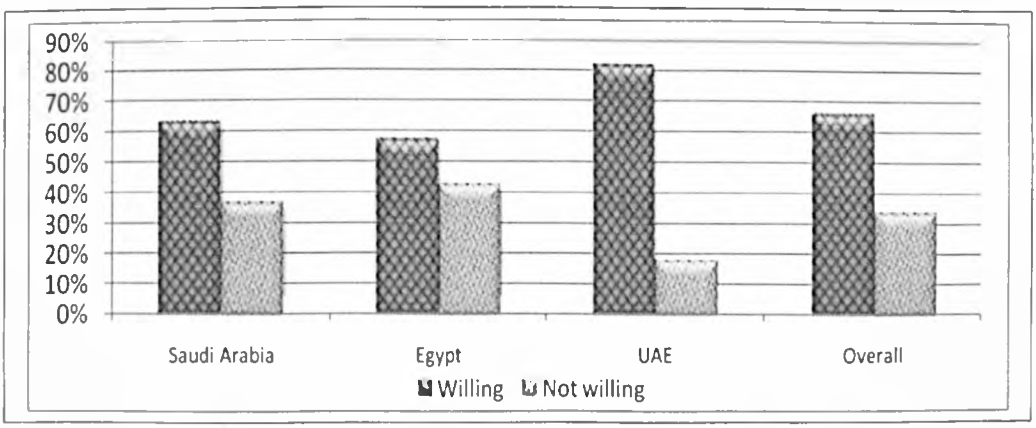


Figure 6.2: Names of respondents' organisations

The table and figure show that some respondents' organisations were willing to provide their names and some were not. In Saudi Arabia, willing organisations numbered 12 (63.16%), while 7 (36.84%) were not willing; in Egypt, 8 (57.14%) and 6 (42.86%); in UAE, 9 (81.82%) and 2 (18.18%), respectively. Overall, the majority of the respondents' organisations willing to provide their names amounted to 29 (65.91%), while there were 15 (34.09%) not willing.

6.2.1.2 Country of organisations (Section 1, Question 2)

This question was designed to classify the country of respondents' organisations, whether they were from Saudi Arabia, Egypt or from the UAE. Table 6.2 and Figure 6.3 present details.

Table 6.2: Country of respondents' organisations

	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Location of respondents' organisations	19	43.20	14	31.80	11	25.00	**44**	**100**

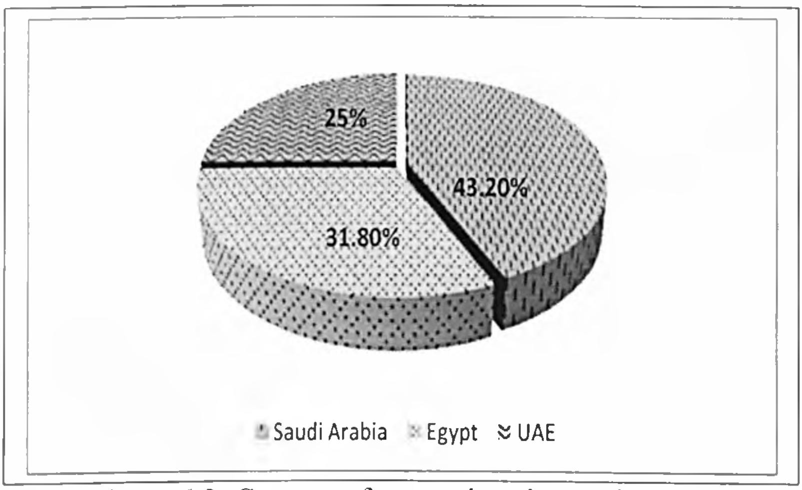


Figure 6.3: Country of respondents' organisations

As can be seen from the table and figure, 44 organisations from the three countries responded and the geographical breakdown of the organisations and percentages were 19 (43.2%) from Saudi Arabia, 14 (31.8%) from Egypt and 11 (25%) from the UAE.

6.2.1.3 Sectors of organisations (Section 1, Question 3)

This question was designed to classify the respondents' organisations by their sector or industry (manufacturing or services). Table 6.3 and Figure 6.4 present the detailed analysis.

Table 6.3: Sectors of respondents' organisations

Sector	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No. of organisations	%	No of organisations	%	**No. of organisations**	**%**
Manufacturing	9	47.37	8	57.14	3	27.27	**20**	**45.45**
Services	10	52.63	6	42.86	8	72.73	**24**	**54.55**
Total	19		14		11		**44**	

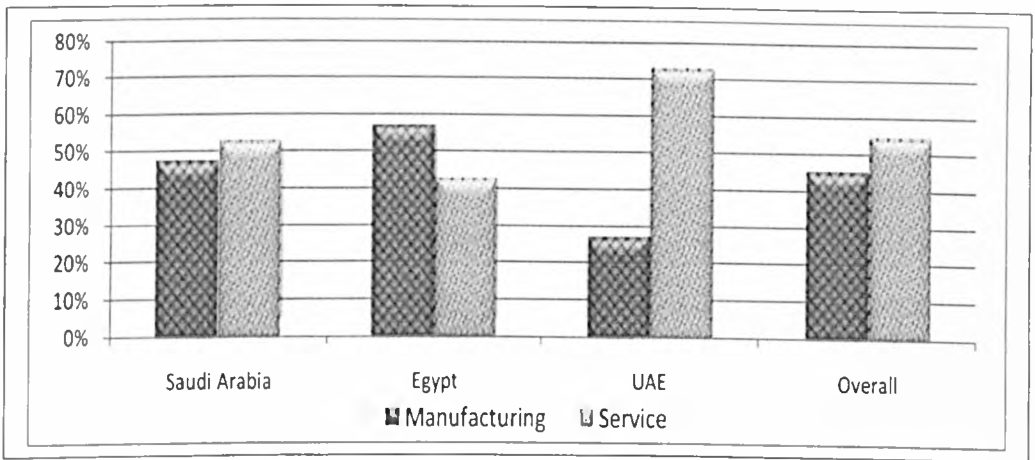


Figure 6.4: Sectors of respondents' organisations

In the table and figure, as can be seen, responding organisations covered both manufacturing and services sectors. In terms of industrial sectors, it is clear that in Saudi Arabia the manufacturing sector organisations make up 47.37% (9), while the services sector organisations make up 52.63% (10). In Egypt, the manufacturing sector has 57.14% (8) of the responding organisations and the services sector has 42.86% (6). Then, in UAE, the services sector takes 72.73% (8) with 27.27% (3) in the manufacturing sector. Overall, the majority of the respondents' organisations sampled are services organisations with 54.55% (24), then manufacturing organisations with 45.45% (20) (see Appendix G, Table G1, for more details).

6.2.1.4 Size of organisations by number of employees (Section 1, Question 4)

This question was designed to classify the sizes of respondents' organisations by the number of their employees (large organisations or SMEs). In the current study, the size refers to the number of employees at the time of the study according to the Commission of the European Communities (2003): SMEs have fewer than 250 employees and large organisations have more than 250. Tables 6.4 and 6.5 and Figure 6.5 present the data.

Table 6.4: Size of respondents' organisations by number of employees

Size	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
SME (≤ 250)	---	---	2	14.29	1	9.09	**3**	**6.82**
Large organisation (> 250)	19	100	12	85.71	10	90.91	**41**	**93.18**
Total	19		14		11		**44**	

Table 6.5: Number of employees of respondents' organisations

Size	No. of employees	Saudi Arabia		Egypt		UAE		**Overall**	
		No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
SME (≤ 250)	51-150	---	---	1	7.14	---	---	**1**	**2.27**
	151-250	---	---	1	7.14	1	9.09	**2**	**4.54**
Large organisation (> 250)	251-500	1	5.26	2	14.28	3	27.27	**6**	**13.64**
	501-1000	2	10.53	4	28.57	4	36.36	**10**	**22.73**
	1001-2500	3	15.79	1	7.14	1	9.09	**5**	**11.36**
	2501-5000	6	31.58	2	14.28	2	18.18	**10**	**22.73**
	5001-10000	4	21.05	3	21.43	---	---	**7**	**15.91**
	> 10000	3	15.79	---	---	---	---	**3**	**6.82**
Total		19		14		11		**44**	

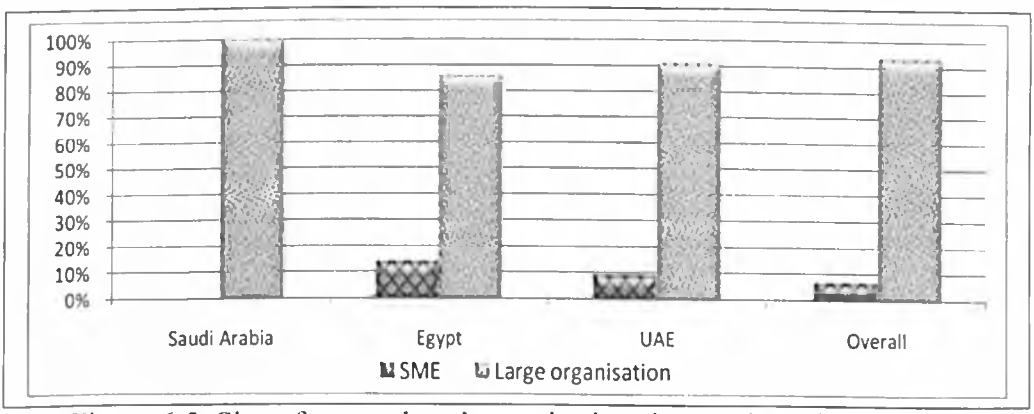


Figure 6.5: Size of respondents' organisations by number of employees

The tables and figure show that the samples of respondents' organisations in this research questionnaire are large ones and SMEs. In Saudi Arabia, the large organisations with more than 250 employees represent 100% (19). But in Egypt, 85.71% (12) are large organisations and only 14.29% (2) are SMEs (fewer than 250 employees). Moreover, in UAE, large organisations make up 90.91% (10) and 9.09% (1) was a SME. Overall, large organisations represent the majority, 93.18% (41), of respondents' organisations against 6.82% (3) for SMEs. Therefore, the majority of organisations implementing Six Sigma in the Middle East are large organisations with more than 250 employees (see Appendix G, Table G2, for more details).

6.2.2 Profile of Individual Respondents (Questionnaire, Section 2)

This profile aims to give a background of the individual respondents surveyed. It includes respondent names, nationalities, organisational positions, Six Sigma roles, working period in the organisation, Six Sigma certification/qualification period and involvement in Six Sigma projects. Each item will be described in full detail and analysis as follows.

6.2.2.1 Respondents' names (Section 2, Question 1)

This optional question was designed to ask the respondents whether they were willing to provide their names or not for the study. Table 6.6 and Figure 6.6 present details.

Table 6.6: Provision of respondents' names

	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of respondents	%	No. of respondents	%	No. of respondents	%	**No. of respondents**	**%**
Willing to provide their names	63	64.95	43	59.72	51	80.95	**157**	**67.67**
Not willing to provide their names	34	35.05	29	40.28	12	19.05	**75**	**32.33**
Total	97		72		63		**232**	

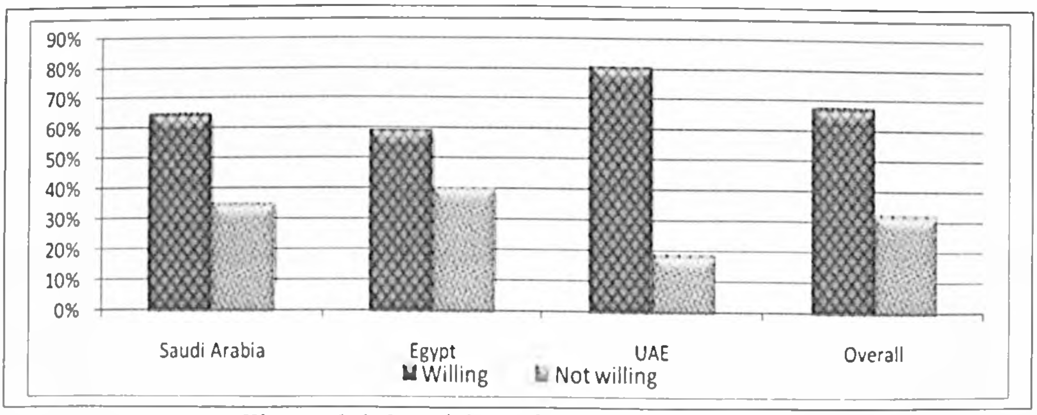


Figure 6.6: Provision of respondents' names

The table and figure show that some respondents were willing to provide their names and some were not willing. In Saudi Arabia, those willing amounted to 63 (64.95%), while 34 (35.05%) were not; in Egypt, 43 (59.72%) and 29 (40.28%); in UAE, 51 (80.95%) and 12 (19.05%), respectively. Overall, the majority of the respondents willing to provide their names totalled 157 (67.67%), while those not willing amounted to 75 (32.33%), for all three countries.

6.2.2.2 *Respondents' nationality (Section 2, Question 2)*

This question was designed to reveal nationality of the respondents (national or non-national). Table 6.7 and Figure 6.7 present details.

Table 6.7: Respondents' nationalities

	Saudi Arabia		Egypt		UAE		**Overall**	
	Saudis	Non-Saudis	Egyptian	Non-Egyptian	UAE	Non-UAE	**National**	**Non-national**
No. of respondents	43	54	68	4	5	58	**116**	**116**
%	44.33	55.67	94.44	5.56	7.94	92.06	**50.00**	**50.00**
Total	97		72		63		**232**	

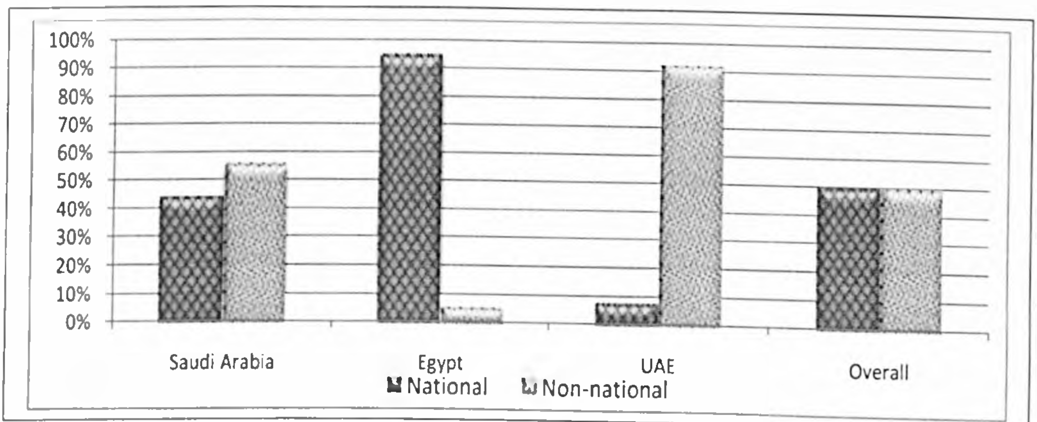


Figure 6.7: Respondents' nationalities

The table and figure show that in Saudi Arabia, 44.33% (43) of respondents were Saudis, while 55.67% (54) were Non-Saudis. In Egypt, Egyptian nationals represented 94.44% (68), while Non-Egyptian represented 5.56% (4). In UAE, UAE nationals represented 7.94% (5), while Non-UAE represented 92.06% (58). Overall, we can see that nationals and non-nationals are the same, with 50% of the total respondents.

6.2.2.3 Respondents' organisational position (Section 2, Question 3)

This question was designed to classify the respondents according to their organisational position (managerial or operational) in their organisations. Table 6.8 and Figure 6.8 show details.

Table 6.8: Respondents' organisational position

Organisational position	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of respondents	%	No. of respondents	%	No. of respondents	%	**No. of respondents**	**%**
Managerial	62	63.92	45	62.50	39	61.90	**146**	**62.93**
Operational	35	36.08	27	37.50	24	38.10	**86**	**37.07**
Total	97		72		63		**232**	

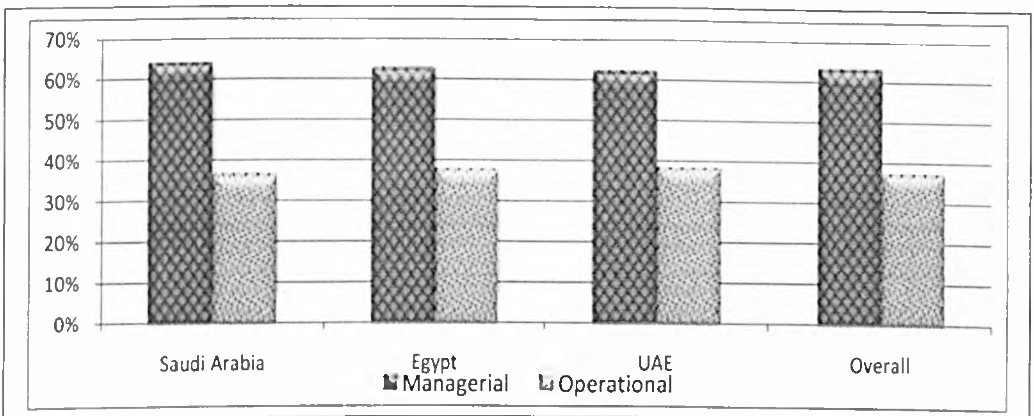


Figure 6.8: Respondents' organisational position

From the table and figure, we can see that the study respondents covered both organisational positions, managerial and operational. In Saudi Arabia, managerial represented 63.92% (62 respondents), while operational represented 36.08% (35); in Egypt, 62.50% (45) and 37.50% (31); in UAE, 61.90% (39), and 38.10% (24), respectively. Overall, the majority of the respondents held managerial positions, 62.93% (146) and 37.07% (86) held operational positions in all three countries.

6.2.2.4 Respondents' Six Sigma role (Section 2, Question 4)

This question was designed to classify respondents according to their Six Sigma role (top management executive manager, quality manager, Six Sigma Champion, MBB, BB and GB) in their organisations. Table 6.9 and Figure 6.9 present details.

Table 6.9: Respondents' Six Sigma role

Six Sigma role	Saudi Arabia		Egypt		UAE		**Overall**	
	No of respondents	%	No of respondents	%	No. of respondents	%	**No. of respondents**	**%**
Top management executive manager	6	6.18	4	5.55	3	4.76	**13**	**5.60**
Quality manager	5	5.15	6	8.33	3	4.76	**14**	**6.04**
Six Sigma Champion	2	2.06	3	4.17	4	6.35	**9**	**3.88**
Master Black Belt (MBB)	24	24.74	13	18.06	12	19.05	**49**	**21.12**
Black Belt (BB)	41	42.27	29	40.28	27	42.86	**97**	**41.81**
Green Belt (GB)	19	19.59	17	23.61	14	22.22	**50**	**21.55**
Total	97		72		63		**232**	

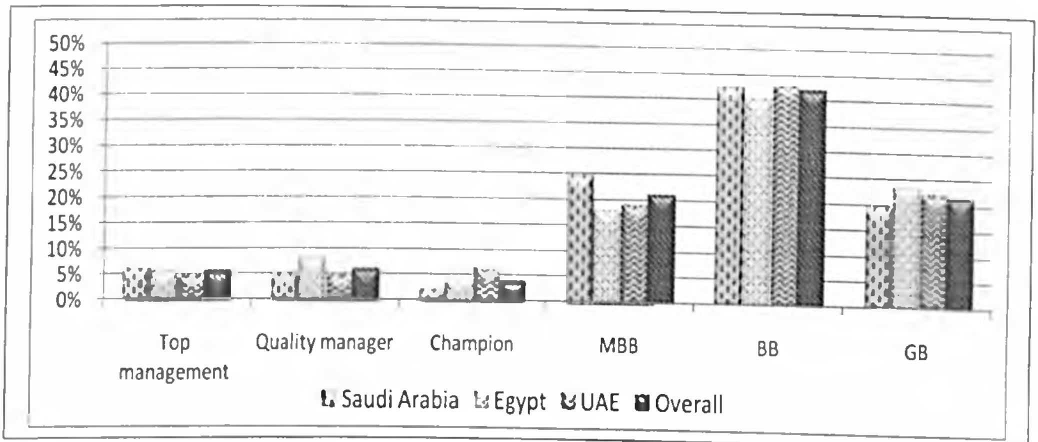


Figure 6.9: Respondents' Six Sigma role

The table and figure, as can be seen, show that the respondents cover all Six Sigma roles: top management executive managers (CEOs, general managers), quality managers, Six Sigma Champions, MBBs, BBs and GBs. Overall, the majority of respondents were 97 BBs, representing 41.81% of all respondents, followed by 50 GBs and 49 MBBs, with 21.55% and 21.12%, respectively. Then, 14 quality managers represented 6.04% of the respondents and only 13 (5.60%) were top management executive managers.

6.2.2.5 Respondents' time in organisation (Section 2, Question 5)

This question was designed to reveal the time the respondents had spent in their organisations. Table 6.10 and Figure 6.10 present details.

Table 6.10: Respondents' time in organisation

Years in organisation	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of respondents	%	No. of respondents	%	No. of respondents	%	**No. of respondents**	**%**
< 2	2	2.06	10	13.89	7	11.11	**19**	**8.19**
< 4	9	9.28	9	12.50	14	22.22	**32**	**13.79**
< 6	13	13 40	16	22.22	11	17.46	**40**	**17.24**
< 8	21	21.65	14	19.44	12	19.05	**47**	**20.26**
< 10	29	30 00	12	16.67	9	14.29	**50**	**21.55**
> 10	23	23.71	11	15.28	10	15.87	**44**	**18.97**
Total	97		72		63		**232**	

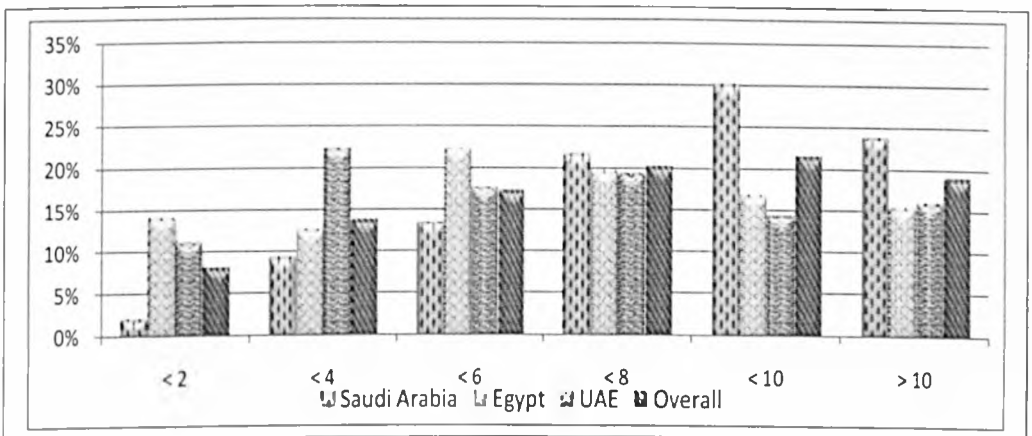


Figure 6.10: Respondents' time in organisation

From the table and figure, we can see that, overall, 50 (21.55%) of the respondents have been working in their organisations for fewer than 10 years, followed by 47 (20.26%) respondents for fewer than 8 years. Then, 44 (18.97%) for more than 10 years and 44 (17.24%) for fewer than 6 years, followed by 32 (13.79%) for fewer than 4 years and just 19 (8.19%) for fewer than 2 years.

6.2.2.6 Respondents' time as Six Sigma certified/qualified (Section 2, Question 6)

This question was designed to reveal the respondents' time as Six Sigma certified/qualified or familiar with it. Table 6.11 and Figure 6.11 present details.

Table 6.11: Respondents' time as Six Sigma certified/qualified

Years as Six Sigma certified/qualified	Saudi Arabia		Egypt		UAE		**Overall**	
	No of respondents	%	No. of respondents	%	No of respondents	%	**No. of respondents**	**%**
< 2	11	11.34	8	11.11	2	3.17	**21**	**9.05**
< 4	16	16.49	12	16.66	7	11.11	**35**	**15.09**
< 6	23	23.37	19	26.39	14	22.22	**56**	**24.14**
< 8	20	20.62	15	20.83	23	36.51	**58**	**25.00**
< 10	19	19.59	11	15.28	8	12.70	**38**	**16.38**
> 10	8	8.25	7	9.72	9	14.29	**24**	**10.35**
Total	97		72		63		**232**	

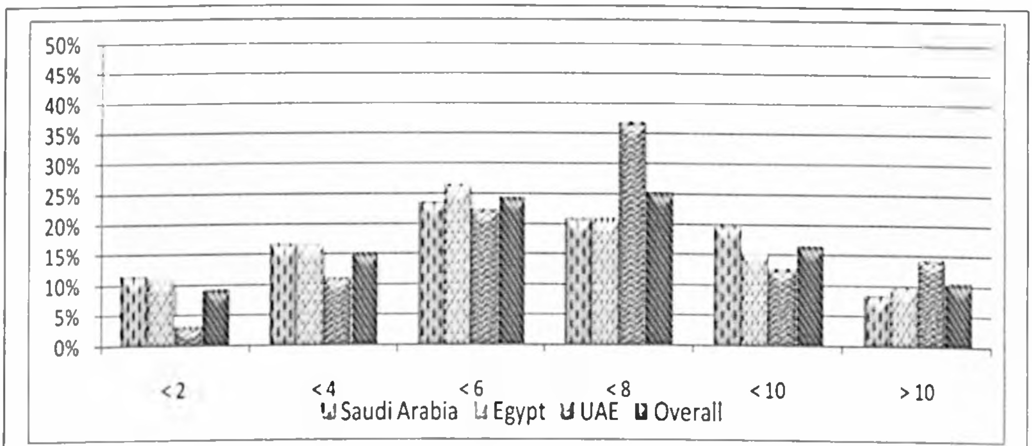


Figure 6.11: Respondents' time as Six Sigma certified/qualified

The table and figure show that, overall, the majority, 58 (25.00%) of respondents were certified/qualified with between 6 and 8 years' experience, followed by 56 (24.14%) with between 4 and 6 years. Then 38 (16.38%) and 35 (15.09%) had been certified/qualified with between 8 and 10 and between 2 and 4 years' experience, respectively, whereas only 24 (10.35%) had more than 10 years and, finally, 21 (9.05%) had fewer than 2 years' experience.

6.2.2.7 *Respondents' involvement in Six Sigma implementation projects (Section 2, Question 7)*

This question asked the respondents about their involvement in Six Sigma projects in their organisations. Table 6.12 and Figure 6.12 present details.

Table 6.12: Respondents' involvement in Six Sigma implementation projects

No. of projects involved	Saudi Arabia		Egypt		UAE		**Overall**	
	No of respondents	%	No of respondents	%	No. of respondents	%	**No. of respondents**	**%**
1 - 10	48	49.48	26	36.11	31	49.21	**105**	**45.26**
11 - 20	33	34.02	24	33.33	17	26.98	**74**	**31.90**
21 - 30	16	16.49	15	20.83	12	19.05	**43**	**18.53**
31 - 40	---	---	7	9.72	3	4.76	**10**	**4.31**
40+	---	---	---	---	---	---	---	---
Total	97		72		63		**232**	

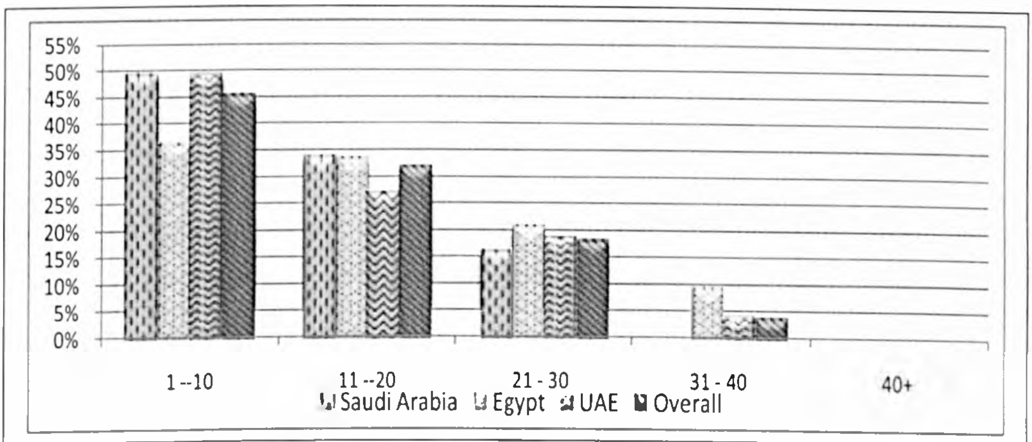


Figure 6.12: Respondents' involvement in Six Sigma implementation projects

The table and figure show involvement of respondents in Six Sigma implementation projects in their organisations. Overall, 105 (45.26%) respondents were involved in between 1 and 10 projects, 74 (31.90%) in 11 to 20 and 43 (18.53%) in 21 to 30. Finally, only 10 (4.31%) were involved in between 31 and 40 projects.

6.2.3 Profile of Six Sigma Programme (Questionnaire, Section 3)

This section aims to present a brief profile of the Six Sigma programme in the responding organisations such as when the Six Sigma programme was started, who were the primary responsible of the programme in the organisation and what other quality improvement programmes were already implemented when the Six Sigma programme started. Each point is presented and described in full detail and analysis as follows.

6.2.3.1 Time of starting Six Sigma programme (Section 3, Question 1)

This question aimed to discover when the Six Sigma programme was initiated in the responding organisations. Table 6.13 and Figure 6.13 present the results.

Table 6.13: Starting time of Six Sigma programme

Programme start	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
< 10 years	3	15.79	2	14.29	---	---	**5**	**11.36**
< 7 years	6	31.58	4	28.57	4	36.36	**14**	**31.82**
< 5 years	7	36.84	3	21.43	4	36.36	**14**	**31.82**
< 3 years	3	15.79	3	21.43	2	18.18	**8**	**18.18**
< 1 year	---	---	2	14.29	1	9.09	**3**	**6.82**
Total	19		14		11		**44**	

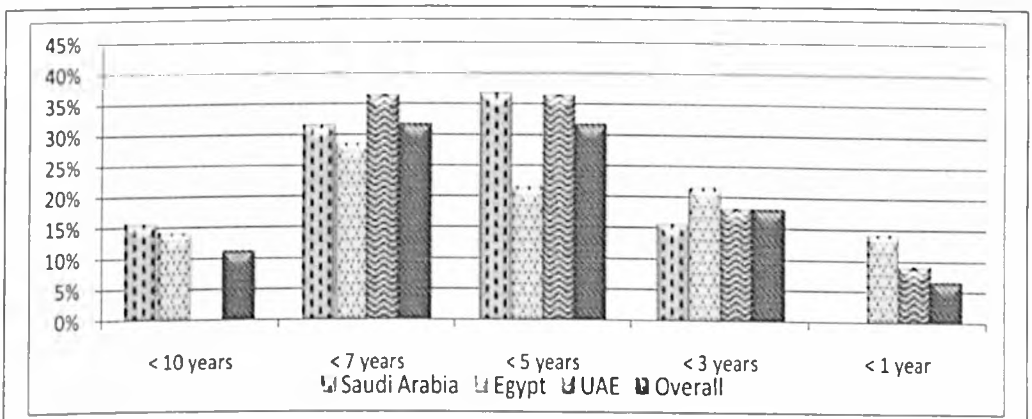


Figure 6.13: Starting time of Six Sigma programme

The table and figure show that, overall, 14 (31.82%) of the responding organisations started the Six Sigma programme during or after 2002 and also 14 (31.82%) started during or after 2004. In addition, 8 (18.18%) started during or after 2005, 5 (11.36%) started during or after 1999 and only 3 (6.82%) during or after 2008.

6.2.3.2 Primary responsible of Six Sigma programme (Section 3, Question 2)

In this question, respondents were asked who was the primary responsible of Six Sigma programme in their organisations. Table 6.14 and Figure 6.14 present details.

Table 6.14: Primary responsible of Six Sigma programme

Primary responsible	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
CEO	4	21.05	2	14.29	2	18.18	**8**	**18.18**
Director	6	31.58	4	28.57	1	9.09	**11**	**25.00**
General manager	3	15.79	3	21.43	2	18.18	**8**	**18.18**
Manager	2	10.53	2	14.29	1	9.09	**5**	**11.37**
External consultant	4	21.05	3	21.43	5	45.45	**12**	**27.27**
Total	19		14		11		**44**	

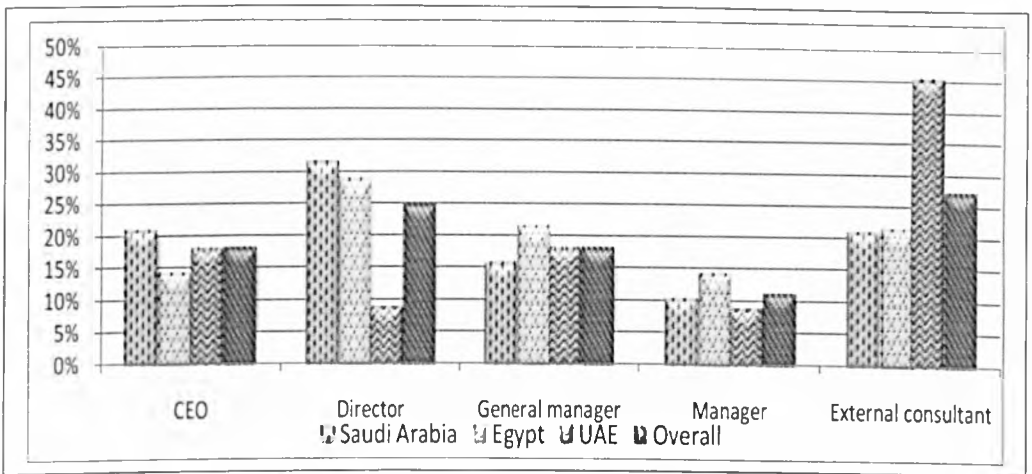


Figure 6.14: Primary responsible of Six Sigma programme

As can be seen, the table and figure indicate that, overall, in 27.27% of cases (12 organisations), external consultants were the primary responsible in 25.00% (11) directors, followed by both CEO and general managers in 18.18% (11) and, finally, by managers in 11.37% (5 organisations).

6.2.3.3 *Previous quality improvement programmes implemented (Section 3, Question 3)*

This question aimed to show what other quality initiatives had been implemented or were being implemented at the time of initiation of the Six Sigma programme in the responding organisations. Table 6.15 and Figure 6.15 show the results.

Table 6.15: Previous quality improvement programmes implemented

Programme	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
TQM	18	94.74	12	85.71	11	100.00	**41**	**93.18**
ISO-9000	17	89.47	13	92.86	11	100.00	**41**	**93.18**
BPR	10	52.63	7	50.00	8	72.73	**25**	**56.82**
Benchmarking	9	47.37	12	85.71	11	100.00	**32**	**72.73**
Total	19		14		11		**44**	

* Respondents asked to tick all applicable

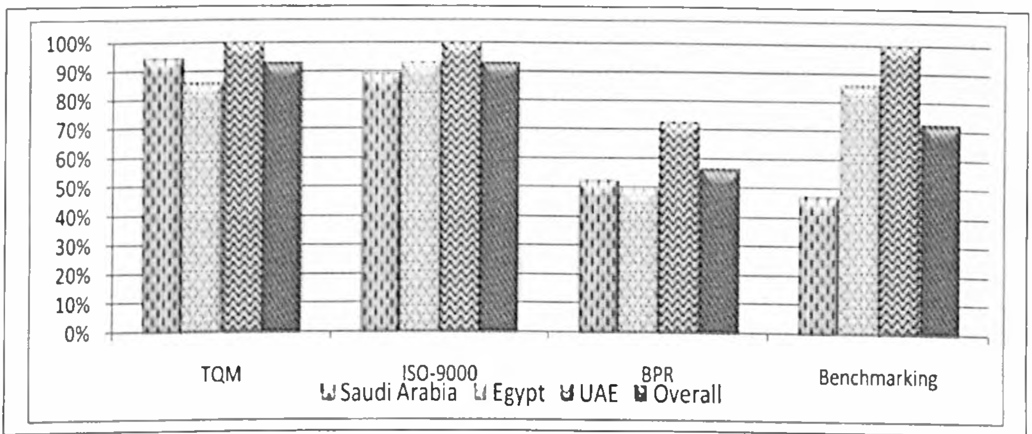


Figure 6.15: Previous quality improvement programmes implemented

In the table and figure, it can be seen that, overall, 93.18% (41 organisations) had implemented TQM and ISO-9000 before implementing Six Sigma, while 72.73% (32) had implemented benchmarking. Only 56.82% (25) had implemented a BPR quality improvement programme.

6.2.4 Profile of Six Sigma Implementation (Questionnaire, Section 4)

The aim of this section was to give an idea of the Six Sigma implementation in the responding organisations. It includes the present status of Six Sigma implementation, current pre-DMAIC and DMAIC stage of implementation, number of Six Sigma projects implemented, completion time in months of Six Sigma projects implemented, percentage of employees involved, the level of organisational resistance to the Six Sigma programme and the importance of the use of external consultants in the planning and implementation of Six Sigma in the organisations. Each item of this section is given with a full detailed description and analysis as follows.

6.2.4.1 Present status of Six Sigma implementation (Section 4, Question 1)

This question aimed to find out the present status of the Six Sigma implementation in the responding organisations. Table 6.16 and Figure 6.16 show the findings.

Table 6.16: Present status of Six Sigma implementation

Status of implementation	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Full	4	21.05	5	35.71	7	63.63	**16**	**36.36**
Partial (DMAIC)	11	57.89	7	50.00	4	36.36	**22**	**50.00**
Starting (Pre-DMAIC)	4	21.05	2	14.29	---	---	**6**	**13.64**
Total	19		14		11		**44**	

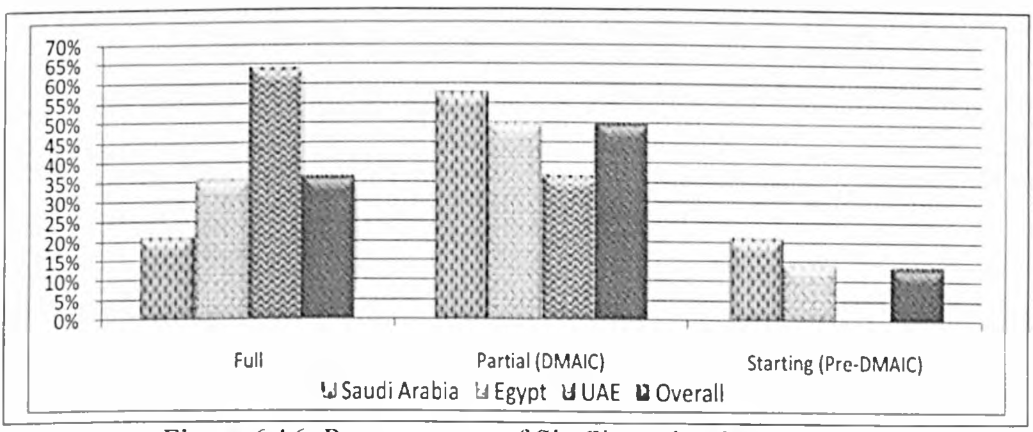


Figure 6.16: Present status of Six Sigma implementation

The table and figure show that, overall, 36.36% (16) of the responding organisations have fully implemented Six Sigma projects, 50.00% (22) partially implemented and 13.64% (6) are at the starting stage of Six Sigma implementation.

6.2.4.2 *Current pre-DMAIC and DMAIC stages of Six Sigma implementation (Section 4, Question 2)*

In this question, the respondents were asked if the Six Sigma programme was not yet fully implemented which pre-DMAIC and DMAIC stages of Six Sigma their organisation is in. Table 6.17 and Figure 6.17 show the findings.

Table 6.17: Current pre-DMAIC and DMAIC stages of Six Sigma implementation

Stage		Saudi Arabia		Egypt		UAE		**Overall**	
		No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	%
Starting (Pre-DMAIC)	Planning	---	---	---	---	---	---	---	---
	Training	1	5.26	1	7.14	---	---	**2**	**4.55**
	Start-up	3	15.79	1	7.14	---	---	**4**	**9.09**
Partially (DMAIC)	Define	2	10.53	1	7.14	---	---	**3**	**6.82**
	Measure	1	5.26	---	---	1	9.09	**2**	**4.55**
	Analyse	3	15.79	2	14.29	2	18.18	**7**	**15.91**
	Improve	2	10.53	2	14.29	---	---	**4**	**9.09**
	Control	2	10 53	2	14.29	1	9.09	**5**	**11.36**
	Review	1	5.26	---	---	---	---	**1**	**2.27**
Total		15		9		4		**28**	
		19		14		11		**44**	

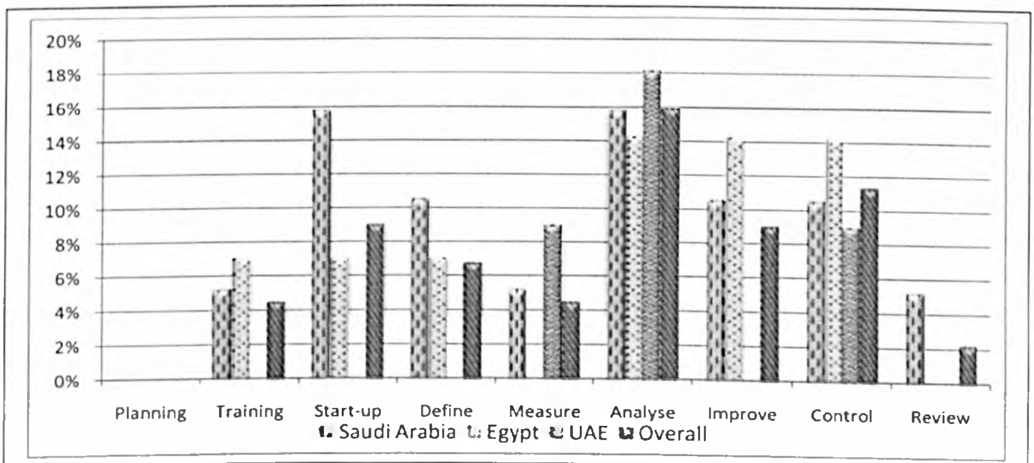


Figure 6.17: Current pre-DMAIC and DMAIC stages of Six Sigma implementation

In the table and figure, it can be seen that, overall, in the pre-DMAIC stage, no organisations were in the planning stage, 4.55% (2) were in the training stage and 9.09% (4) were in the start-up stage. In addition, in the DMAIC stage, 6.82% (3) were in the define stage, 4.55% (2) in the measure stage, 15.91% (7) in the analyse stage, 9.09% (4) in the improve stage, 11.36% (5) in the control stage and, finally, 2.27% (1) in the review stage.

6.2.4.3 Number of Six Sigma projects implemented (Section 4, Question 3)

This question asked respondents about how many Six Sigma projects had been implemented so far in their organisations. Table 6.18 and Figure 6.18 give details.

Table 6.18: Number of Six Sigma projects implemented

Projects	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No. of organisations	%	No of organisations	%	**No. of organisations**	**%**
1 - 5	3	15.79	2	14.28	---	14.28	**5**	**11.36**
6 - 10	7	36.84	4	28.57	4	28.57	**15**	**34.10**
11 - 15	6	31.58	5	35.71	1	35.71	**12**	**27.27**
16 - 25	1	5.26	---	---	5	---	**6**	**13.64**
26 - 40	2	10.53	3	21.43	1	21.43	**6**	**13.64**
40+	---	---	---	---	---	---	---	---
Total	19		14		11		**44**	

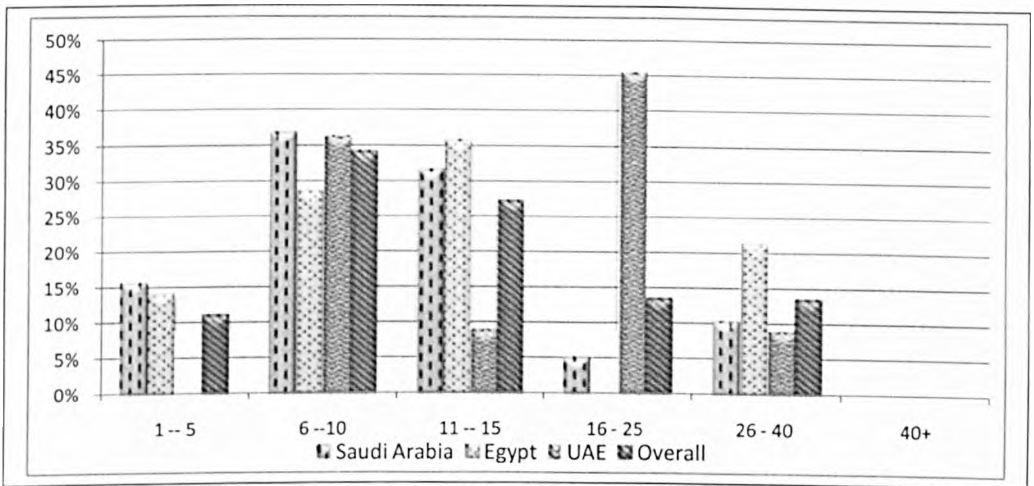


Figure 6.18: Number of Six Sigma projects implemented

The table and figure show that, overall, 34.10% (15) had implemented 6-10 projects, 27.27% (12) had implemented 11-15, followed by 13.64% (6) with 16-25 projects implemented, a further 13.64% (6) with 26-40 projects and just 11.36% (5) with only 1-5 projects. No organisation had so far implemented more than 40 projects.

6.2.4.4 Completion time of Six Sigma projects (Section 4, Question 4)

This question was designed to ask the respondents about the completion time in months of Six Sigma projects implemented in their organisations. Table 6.19 and Figure 6.19 show the findings.

Table 6.19: Completion time (months) of Six Sigma projects

Months	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	%
1 - 4	4	21.05	2	14.29	1	9.09	**7**	**15.91**
5 - 8	12	63.16	7	50.00	8	72.73	**27**	**61.36**
9 - 12	2	10.53	4	28.57	2	18.18	**8**	**18.18**
13 - 15	1	5.26	1	7.14	---	---	**2**	**4.55**
15+	---	---	---	---	---	---	---	---
Total	19		14		11		**44**	

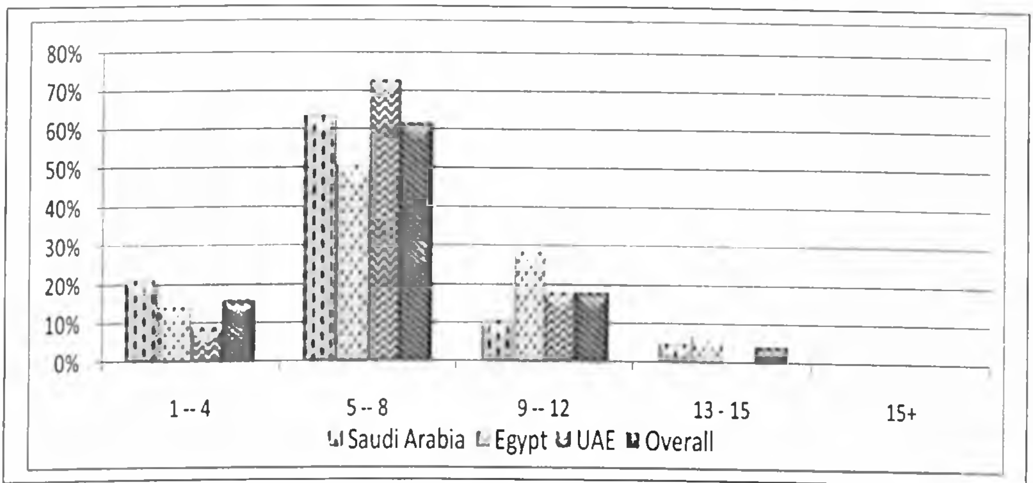


Figure 6.19: Completion time (months) of Six Sigma projects

The table and figure show that, overall, the majority, 27 (61.36%), of responding organisations completed their Six Sigma projects in 5-8 months, 7 (15.91%) in 1-4 months, 8 (18.18%) in 9-12 months and just 2 (4.55%) needed more than a year (13-15 months) to complete a project.

6.2.4.5 Employee involvement (Section 4, Question 5)

This question asked the respondents about the percentage of employees involved in Six Sigma project implementation in their organisations. Table 6.20 and Figure 6.20 give details.

Table 6.20: Percentage of employees involved in Six Sigma projects

% Employees	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No of organisations	%	No. of organisations	%	**No. of organisations**	%
1 - 20%	8	42.11	5	35.71	6	54.55	**19**	**43.18**
21 - 30%	7	36.84	6	42.86	2	18.18	**15**	**34.10**
31 - 40%	3	15.79	3	21.43	3	27.27	**9**	**20.45**
41 - 50%	1	5.26	---	---	---	---	**1**	**2.27**
> 50%	---	---	---	---	---	---	---	---
Total	19		14		11		**44**	

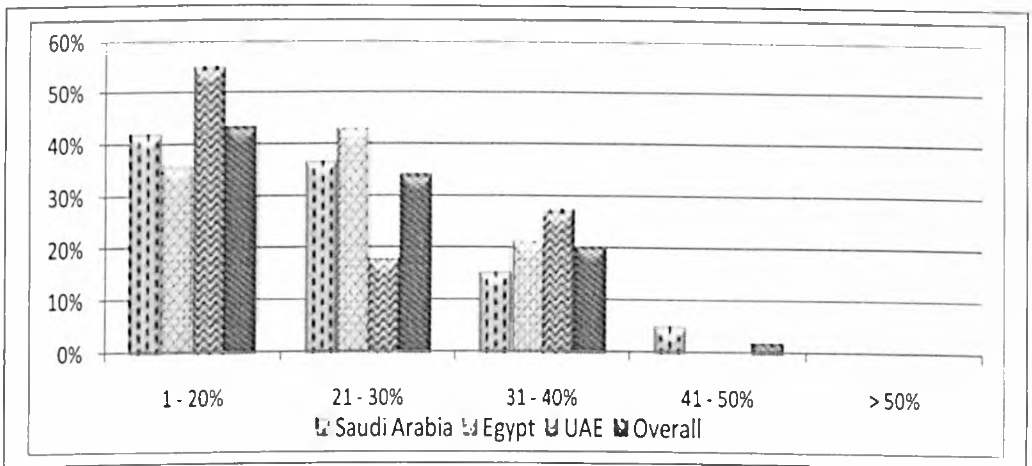


Figure 6.20: Percentage of employees involved in Six Sigma projects

As can be seen, the table and figure indicate that, overall, 43.18% (19 organisations) involved 1-20% of their employees in the Six Sigma projects, while 34.10% (15) involved 21-30%. In addition, 20.45% (9) involved 31-40%, while only 2.27% (1) involved 41-50% of its employees in the Six Sigma projects and no organisation involved more than 50%.

6.2.4.6 Organisational resistance to Six Sigma (Section 4, Question 6)

This question asked the respondents about the level of organisational resistance to the Six Sigma programme in their organisations. Table 6.21 and Figure 6.21 give details.

Table 6.21: Level of organisational resistance to Six Sigma

Resistance level	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
No resistance	15	79.95	12	85.71	10	90.91	**37**	**84.10**
Minor resistance	3	15.79	1	7.14	---	---	**4**	**9.10**
Moderate resistance	1	5.26	1	7.14	1	9.09	**3**	**6.80**
Major resistance	---	---	---	---	---	---	---	---
Great resistance	---	---	---	---	---	---	---	---
Total	19		14		11		**44**	

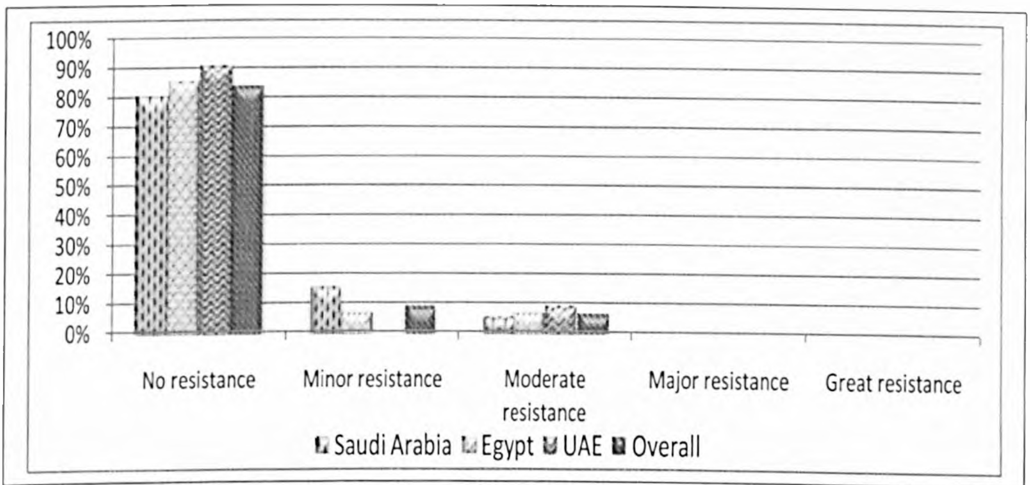


Figure 6.21: Level of organisational resistance to Six Sigma

The table and figure show that, overall, in 84.10% (37) of cases, there was no organisational resistance at all, 9.10% (4) had minor resistance, while 6.80% (3) had moderate resistance and there was no major resistance in any organisation.

6.2.4.7 Importance of use of external consultants (Section 4, Question 7)

This question asked about the importance of the use of external consultants in the planning and implementation of Six Sigma in the organisations. Table 6.22 and Figure 6.22 show the findings.

Table 6.22: Importance of use of external consultants

	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of respondents	%	No of respondents	%	No. of respondents	%	**No. of respondents**	**%**
Very important	69	71.13	41	56.94	55	87.30	**165**	**71.12**
Important	21	21.65	19	26.39	8	12.70	**48**	**20.69**
Neutral	7	7.22	12	16.67	---	---	**19**	**8.19**
Not important	---	---	---	---	---	---	---	---
Not at all	---	---	---	---	---	---	---	---
Total	97		72		63		**232**	

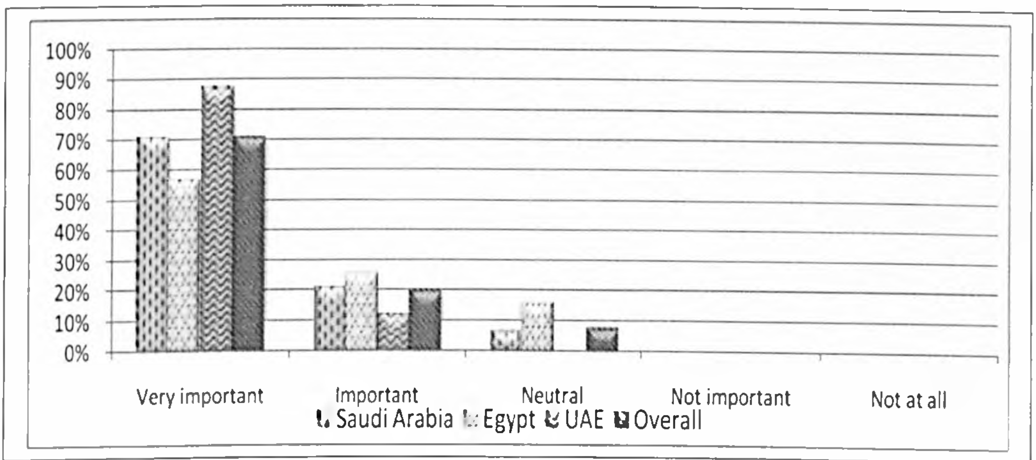


Figure 6.22: Importance of use of external consultants

As can be seen in the table and figure, in Saudi Arabia, 69 (71.13%) of respondents see the use of external consultants to assist them in implementing Six Sigma as very important, 21 (21.65%) see it as important and only 7 (7.22%) see it as neutral. In Egypt, we found that 41 (59.94%) see the use of external consultants as very important, while 19 (26.39%) see it as important and 12 (16.67%) see it as neutral. In the UAE, 55 (87.30%) see the use of external consultants as very important, while the remaining 8 (12.70%) see it as important. Overall, the majority of the sample, 165 (71.12%) of respondents, see the use of external consultants to assist them in planning and implementing Six Sigma as very important, 48 (20.69%) see it as important and only 19 (8.19%) see it as neutral.

6.3 Analysis of Key Issues of Six Sigma Implementation

The following sub-sections provide a detailed description and analysis of each research question of the current research as outlined in Section 1.4. It includes the four key issues related to Six Sigma implementation in the Middle East organisations in the present research: the main reasons for/ benefits of their implementation, the main challenges, the major CSFs and the rating of satisfaction with implementation. The quantitative analysis for each question will include reliability analysis, descriptive statistics analysis, perspective analysis and statistical analysis that include the significant difference analysis and correlation analysis. The analysis follows the questionnaire sequence of questions, with their sections in brackets.

6.3.1 Reasons for/ Benefits of Six Sigma Implementation (Questionnaire, Section 5)

The aim of the question of this section is to obtain the view of respondents on the main reasons for/ benefits of implementation of the Six Sigma programme in the Middle East organisations and they were asked to rate the criticality and the significance of the reasons/benefits based on their experience. A list of 15 reasons/benefits identified by literature review and pilot study was arranged in random order and a five-point Likert scale for criticality and significance (1 = not at all, 2 = less significant, 3 = significant, 4 = very significant and 5 = highly significant) was provided against each. A detailed description and analysis follows.

6.3.1.1 Reliability analysis

Table 6.23 presents results of the reliability (internal consistency) analysis for the main reasons for/ benefits of Six Sigma implementation in the Middle East organisations using Cronbach's alpha (α) and item-to-total correlation for the 15 items. Cronbach's alpha provides a measure of internal consistency which reflects how well each of the items correlates with the entire scale or sub-scale, while the purpose of the item-to-total correlation measure is that it determines the relationship of a particular item to the rest of the items in that dimension. Item-to-total correlation ranges from 0.432 to 0.754, which falls into the acceptable level; as none was found to have a value below the acceptable minimum of 0.30 (see Section 5.9.1), no items needed removal to improve the scale reliability. It can therefore be concluded that this question has a high internal consistency and is therefore reliable. The overall value of Cronbach α was 0.880, while the values for Saudi Arabia, Egypt and UAE were 0.882, 0.878 and 0.900, respectively. Since all the Cronbach's α were greater than 0.7, the instrument was therefore deemed reliable and should provide the expected results (see Section 5.9.1).

6.3.1.2 Descriptive analysis

Descriptive analysis is used to describe the data obtained, investigate the sample and give a good picture of its characteristics to help the researcher in answering the research question. Descriptive statistics are used here for reporting the characteristics of the surveyed organisations and simultaneously providing adequate statistical support to the findings such as mean, standard deviation, frequencies, percentages and ranking. Table 6.24 gives the descriptive statistics analysis of the reasons for/ benefit of the Six Sigma implementation in the Middle East and shows the mean, standard deviation and ranking of each reason/benefit based on the data given by the respondents. Figure 6.23 represents the results graphically in the form of bar charts.

The analysis shows that the values of the mean are high, ranging between 4.49 and 4.92. In addition, few items have the same ranks. Overall, the most significant reason for/ benefit of the Six Sigma implementation programme in the Middle East was 'improving customer satisfaction (understanding customer needs and expectations)' followed by 'improving business, financial performance and organisation efficiency'. The third was 'building organisation reputation and creating new customer opportunities', whereas 'improving process performance continuously from reactive to proactive' was fourth. The fifth reason/benefit in ranking was 'improving and increasing earnings, profitability and market share'.

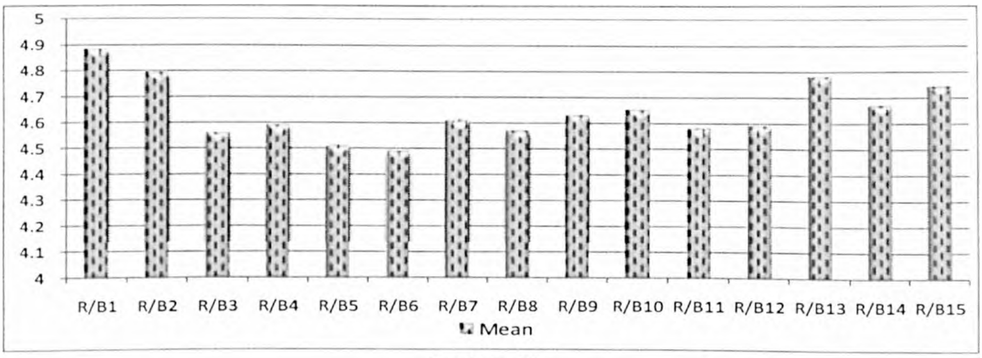
Table 6.23: Reliability (internal consistency) - Cronbach's alpha values of reasons for/ benefits of Six Sigma implementation

No.	Reasons for/ benefits of Six Sigma implementation	Saudi Arabia (N=97)		Egypt (N=72)		UAE (N=63)		**Overall (N=232)**	
		Corrected item-total correlation	Result	Corrected item-total correlation	Result	Corrected item-total correlation	Result	**Corrected item-total correlation**	**Result**
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	0.432	Accepted	0.476	Accepted	0.527	Accepted	**0.471**	**Accepted**
R/B2	Improving business, financial performance and organisation efficiency	0.485	Accepted	0.414	Accepted	0.508	Accepted	**0.441**	**Accepted**
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	0.476	Accepted	0.547	Accepted	0.475	Accepted	**0.489**	**Accepted**
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	0.510	Accepted	0.535	Accepted	0.526	Accepted	**0.519**	**Accepted**
R/B5	Gaining competitive advantage	0.535	Accepted	0.597	Accepted	0.637	Accepted	**0.559**	**Accepted**
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	0.498	Accepted	0.488	Accepted	0.554	Accepted	**0.496**	**Accepted**
R/B7	Changing and improving organisation culture	0.469	Accepted	0.457	Accepted	0.709	Accepted	**0.491**	**Accepted**
R/B8	Achieving faster and on-time delivery	0.754	Accepted	0.686	Accepted	0.706	Accepted	**0.694**	**Accepted**
R/B9	Decreasing employee work loads for undesirable work	0.431	Accepted	0.445	Accepted	0.558	Accepted	**0.470**	**Accepted**
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	0.736	Accepted	0.642	Accepted	0.732	Accepted	**0.701**	**Accepted**
R/B11	Reducing capital spending (operational costs, overhead production costs)	0.724	Accepted	0.625	Accepted	0.709	Accepted	**0.671**	**Accepted**
R/B12	Using resources effectively	0.543	Accepted	0.515	Accepted	0.515	Accepted	**0.528**	**Accepted**
R/B13	Building organisation reputation and creating new customer opportunities	0.498	Accepted	0.562	Accepted	0.547	Accepted	**0.525**	**Accepted**
R/B14	Improving process performance continuously from reactive to proactive	0.470	Accepted	0.471	Accepted	0.547	Accepted	**0.475**	**Accepted**
R/B15	Improving and increasing earnings, profitability and market share	0.529	Accepted	0.519	Accepted	0.466	Accepted	**0.498**	**Accepted**
Cronbach's α value		**0.882**		**0.878**		**0.900**		**0.880**	

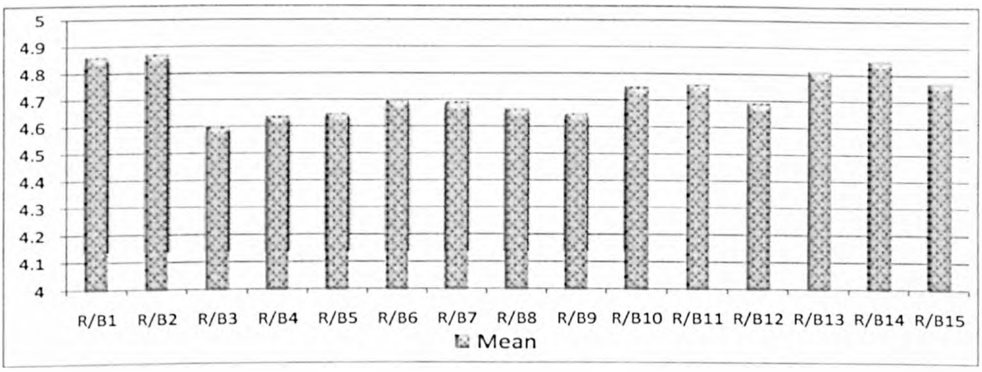
Table 6.24: Descriptive analysis (mean, standard deviation (SD) and ranking) of reasons for/ benefits of Six Sigma implementation

No.	Reasons for/ benefits of Six Sigma implementation	Saudi Arabia (N=97)			Egypt (N=72)			UAE (N=63)			**Overall (N=232)**		
		Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	**Mean**	**SD**	**Rank**
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	4.88	.361	1	4.86	.382	2	4.87	.336	3	**4.87**	**.399**	**1**
R/B2	Improving business, financial performance and organisation efficiency	4.79	.432	2	4.87	.373	1	4.92	.272	1	**4.86**	**.428**	**2**
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	4.56	.705	13	4.60	.725	15	4.76	.429	14	**4.64**	**.651**	**15**
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	4.59	.760	9*	4.64	.628	14	4.81	.396	9*	**4.68**	**.642**	**11***
R/B5	Gaining competitive advantage	4.51	.937	14	4.65	.490	12*	4.84	.368	5*	**4.68**	**.706**	**11***
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	4.49	.843	15	4.70	.411	8	4.86	.353	4	**4.68**	**.633**	**11***
R/B7	Changing and improving organisation culture	4.61	.641	8	4.69	.422	9*	4.81	.396	9*	**4.70**	**.530**	**8***
R/B8	Achieving faster and on-time delivery	4.57	.691	12	4.67	.628	11	4.82	.386	8	**4.68**	**.608**	**11***
R/B9	Decreasing employee work loads for undesirable work	4.63	.618	7	4.65	.429	12*	4.83	.383	7	**4.70**	**.524**	**8***
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	4.65	.646	6	4.75	.496	7	4.74	.456	15	**4.71**	**.543**	**6***
R/B11	Reducing capital spending (operational costs, overhead production costs)	4.58	.674	11	4.76	.489	6	4.80	.408	11	**4.71**	**.563**	**6***
R/B12	Using resources effectively	4.59	.800	9*	4.69	.712	9*	4.78	.490	13	**4.69**	**.702**	**10**
R/B13	Building organisation reputation and creating new customer opportunities	4.78	.484	3	4.81	.432	4	4.89	.317	2	**4.83**	**.559**	**3**
R/B14	Improving process performance continuously from reactive to proactive	4.67	.746	5	4.85	.399	3	4.84	.482	5*	**4.79**	**.519**	**4**
R/B15	Improving and increasing earnings, profitability and market share	4.74	.666	4	4.77	.467	5	4.79	.446	12	**4.77**	**.445**	**5**

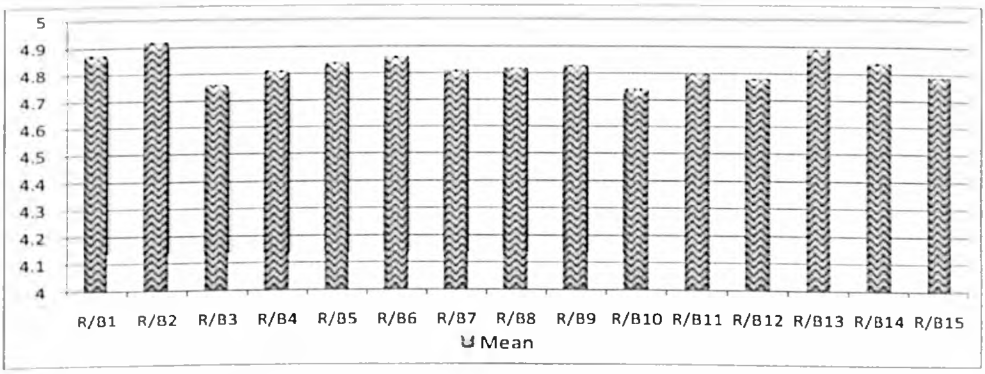
* Another item(s) with same rank (tied rank)



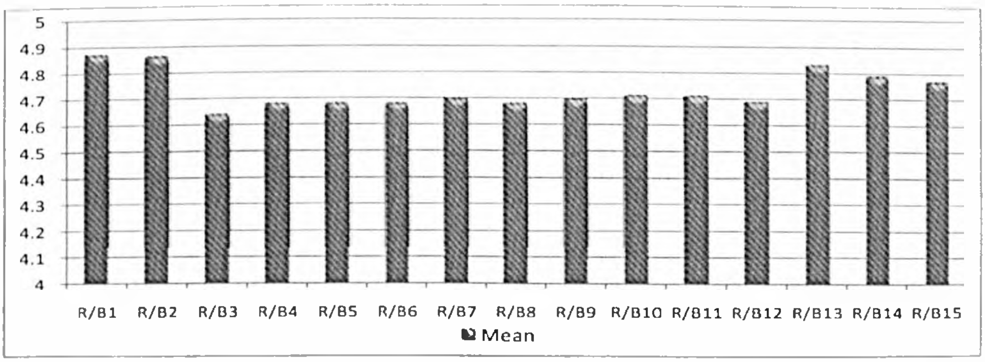
Saudi Arabia



Egypt



UAE



Overall

Figure 6.23: Mean values of reasons for/ benefits of Six Sigma implementation

6.3.1.3 *Perspective analysis*

The reasons for/ benefits of Six Sigma collected in this study can also be analysed from the perspective of tangible and intangible. The tangible reasons/benefits are issues that impact on organisations and can be measured in monetary terms. Intangible reasons/benefits are issues that impact on organisations and consider subjective reasons/benefits that cannot be measured in monetary terms. Table 6.25 presents classification of reasons for/ benefits of Six Sigma implementation under tangible and intangible dimensions.

Table 6.25: Classification of reasons for/ benefits of Six Sigma implementation under tangible and intangible dimensions

Dimension	R/B No.	Reasons for/ benefits of Six Sigma implementation
Tangible	R/B2	Improving business, financial performance and organisation efficiency
	R/B3	Reducing defect /error rate, waste chain reduction and process cycle times
	R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)
	R/B8	Achieving faster and on-time delivery
	R/B9	Decreasing employee work loads for undesirable work
	R/B11	Reducing capital spending (operational costs, overhead production costs)
	R/B12	Using resources effectively
Intangible	R/B1	Improving customer satisfaction (understanding customer needs and expectations)
	R/B5	Gaining competitive advantage
	R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)
	R/B7	Changing and improving organisation culture
	R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance
	R/B13	Building organisation reputation and creating new customer opportunities
	R/B14	Improving process performance continuously from reactive to proactive
	R/B15	Improving and increasing earnings, profitability and market share

6.3.1.4 Statistical analysis

Regarding the research objectives, the statistical analysis for this item will use the significant difference analysis and correlation analysis as follows.

6.3.1.4.1 Significant difference analysis

To investigate the current status of Six Sigma implementation in the Middle East context, differences in the reasons for/ benefits of Six Sigma implementation programme in the two perspective dimensions, the three countries, the two sectors, the two sizes and the two organisational positions were analysed to find whether there is a significant difference between them as follows.

- *Differences in reasons/benefits between perspective dimensions (tangible and intangible)*

For determination of whether there is a difference of the reasons for/ benefits of the Six Sigma implementation programme between the tangible and intangible perspective dimensions of reasons/benefits, a Wilcoxon test was run. Table 6.26 presents results.

Table 6.26: Wilcoxon test of reasons/benefits of Six Sigma implementation between perspective dimensions (tangible and intangible)

	Wilcoxon Test							
					Differences (N=232)			
Intangible - Tangible		(N=232)	Mean Rank	Sum of Rank	Z	*P*	Sig. (2-tailed)	Difference
	Negative Rank	67[a]	78.46	5257.00	**-3.561[a]**	**0.036**	***P* < 0.05**	**YES**
	Positive Rank	72[b]	90.31	6502.00				
	Tiles	93[c]	---	---				

a. Intangible < Tangible, b. Intangible > Tangible, c. Intangible = Tangible

The results of Table 6.26 confirm that there is a quite significant difference (Z = -3.561 and $P < 0.05$). The tangible reasons/benefits generated higher mean rank compared to intangible reasons/benefits.

- *Differences in reasons/benefits between countries (Saudi Arabia, Egypt and UAE)*

To determine whether there is significant difference in the reasons for/ benefits of the Six Sigma implementation programme between the three Middle East countries (Saudi Arabia, Egypt and UAE), a Kruskal-Wallis test was made. Table 6.27

presents the results which confirm that in 11 reasons/benefits, there are no significant differences (Chi-squared ranging between 0.102 and 5.603, and $P > 0.05$), but there are significant differences (Chi-squared = 7.695 and $P < 0.05$; Chi-squared = 6.120, and $P < 0.05$; Chi-squared = 12.804 and $P < 0.01$; and Chi-squared = 8.273 and $P < 0.01$) in the other 4 reasons/benefits (R/B2, R/B3, R/B6 and R/B7), respectively. But for the mean of all the reasons/benefits, there is no significant difference (Chi-squared = 1.136 and $P > 0.05$).

- *Differences in reasons/benefits between sectors (manufacturing and services)*

A Mann-Witney test was used to determine presence of significant difference in the reasons for/ benefits of the implementation of the Six Sigma programme between the two sectors (manufacturing and services) and Table 6.28 shows the results. These confirm that in 13 reasons/benefits, there are no significant differences (Z ranging between -0.226 and -1.747 and $P > 0.05$), but differences are significant (Z = -2.293 and $P < 0.05$, and Z = -3.640 and $P < 0.001$) for the other two reasons/benefits (R/B3 and R/B14), respectively. For the mean of all the reasons/benefits, there is no significant difference (Z = -1.768 and $P > 0.05$).

- *Differences in reasons/benefits between sizes of organisation (large and SME)*

Table 6.29 shows the results of a Mann-Witney test between the two sizes (large organisation and SME) which confirm that in all 15 reasons/benefits, there are no significant differences (Z ranging between -0.048 and -1.553 and $P > 0.05$) and for the mean of all the reasons/benefits, there is no significant difference (Z = -0.205 and $P > 0.05$).

- *Differences in reasons/benefits between organisational positions (managerial and operational)*

In determining whether there is a difference in the reasons for/ benefits of the Six Sigma implementation programme between the two organisational positions (managerial and operational), a Mann-Witney test was made and Table 6.30 shows the results. These confirm that in 14 reasons/benefits, there are no significant differences (Z ranging between -0.039 and -1.544 and $P > 0.05$), but there is a significant difference (Z = -2.291 and $P < 0.05$) for the one remaining reason/benefit (R/B5). For the mean of all the reasons/benefits, there is no significant difference (Z = -0.055 and $P > 0.05$).

Table 6.27: Kruskal-Wallis test on reasons for/ benefits of Six Sigma implementation between countries (Saudi Arabia, Egypt and UAE)

No.	Reasons for/ benefits of Six Sigma implementation	Kruskal-Wallis Test						
		Mean Rank			Differences (N=232)			
		Saudi Arabia (N=97)	Egypt (N=72)	UAE (N=63)	Chi-squared	*P*	Sig. (2-tailed)	Difference
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	113.76	117.00	120.15	.892	0.640	$P > 0.05$	NO
R/B2	Improving business, financial performance and organisation efficiency	107.79	119.49	126.49	7.695	0.021*	$P < 0.05$	YES
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	107.55	119.33	127.04	6.120	0.047*	$P < 0.05$	YES
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	111.27	115.72	125.45	2.950	0.229	$P > 0.05$	NO
R/B5	Gaining competitive advantage	112.23	114.98	124.81	2.185	0.335	$P > 0.05$	NO
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	102.99	125.69	126.79	12.804	0.002**	$P < 0.01$	YES
R/B7	Changing and improving organisation culture	105.41	125.53	123.26	8.273	0.016*	$P < 0.05$	YES
R/B8	Achieving faster and on-time delivery	108.53	116.85	128.38	5.603	0.061	$P > 0.05$	NO
R/B9	Decreasing employee work loads for undesirable work	108.75	122.33	121.77	4.362	0.113	$P > 0.05$	NO
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	110.22	120.03	122.13	2.621	0.270	$P > 0.05$	NO
R/B11	Reducing capital spending (operational costs, overhead production costs)	107.40	122.56	123.60	5.279	0.071	$P > 0.05$	NO
R/B12	Using resources effectively	111.64	116.74	123.71	2.165	0.339	$P > 0.05$	NO
R/B13	Building organisation reputation and creating new customer opportunities	113.27	114.97	123.22	2.128	0.345	$P > 0.05$	NO
R/B14	Improving process performance continuously from reactive to proactive	116.88	117.10	115.23	.102	0.950	$P > 0.05$	NO
R/B15	Improving and increasing earnings, profitability and market share	117.82	113.13	118.31	.536	0.765	$P > 0.05$	NO
	Reasons for/ Benefits of Six Sigma implementation (mean)	**114.53**	**112.84**	**123.71**	**1.136**	**0.567**	**$P > 0.05$**	**NO**

* Significant at $P < 0.05$

** Significant at $P < 0.01$

Table 6.28: Mann-Whitney test on reasons for/ benefits of Six Sigma implementation between sectors (manufacturing and services)

No.	Reasons for/ benefits of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Manufacturing Sector (N=113)	Services Sector (N=119)	Z	*P*	Sig. (2-tailed)	**Difference**
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	111.85	120.92	-1.638	0.101	$P > 0.05$	NO
R/B2	Improving business, financial performance and organisation efficiency	112.09	120.69	-1.519	0.129	$P > 0.05$	NO
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	108.77	123.84	-2.293	0.022*	$P < 0.05$	YES
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	110.70	122.01	-1.680	0.093	$P > 0.05$	NO
R/B5	Gaining competitive advantage	112.85	119.96	-1.009	0.313	$P > 0.05$	NO
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	110.76	121.95	-1.747	0.081	$P > 0.05$	NO
R/B7	Changing and improving organisation culture	114.15	118.73	-.696	0.486	$P > 0.05$	NO
R/B8	Achieving faster and on-time delivery	111.08	121.65	-1.551	0.121	$P > 0.05$	NO
R/B9	Decreasing employee work loads for undesirable work	114.60	118.31	-.589	0.556	$P > 0.05$	NO
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	115.73	117.23	-.226	0.821	$P > 0.05$	NO
R/B11	Reducing capital spending (operational costs, overhead production costs)	113.76	119.10	-.794	0.427	$P > 0.05$	NO
R/B12	Using resources effectively	112.38	120.42	-1.208	0.227	$P > 0.05$	NO
R/B13	Building organisation reputation and creating new customer opportunities	114.46	118.44	-.696	0.487	$P > 0.05$	NO
R/B14	Improving process performance continuously from reactive to proactive	107.35	125.19	-3.640	0.000***	$P < 0.001$	YES
R/B15	Improving and increasing earnings, profitability and market share	120.23	112.95	-1.175	0.240	$P > 0.05$	NO
Reasons for/ Benefits of Six Sigma implementation (mean)		**108.90**	**123.71**	**-1.768**	**.077**	**$P > 0.05$**	**NO**

* Significant at $P < 0.05$

*** Significant at $P < 0.001$

Table 6.29: Mann-Whitney test on reasons for/ benefits of Six Sigma implementation between organisation sizes (large and SME)

No.	Reasons for/ benefits of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Large organisation (N=218)	SME (N=14)	Z	*P*	Sig. (2-tailed)	Difference
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	116.38	118.36	-.170	0.865	$P > 0.05$	NO
R/B2	Improving business, financial performance and organisation efficiency	115.80	127.39	-.975	0.329	$P > 0.05$	NO
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	115.21	136.64	-1.553	0.120	$P > 0.05$	NO
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	116.09	122.82	-.476	0.634	$P > 0.05$	NO
R/B5	Gaining competitive advantage	115.47	132.45	-1.149	0.250	$P > 0.05$	NO
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	115.33	134.64	-1.436	0.151	$P > 0.05$	NO
R/B7	Changing and improving organisation culture	116.36	118.61	-.163	0.871	$P > 0.05$	NO
R/B8	Achieving faster and on-time delivery	116.02	124.04	-.561	0.575	$P > 0.05$	NO
R/B9	Decreasing employee work loads for undesirable work	115.41	133.43	-1.363	0.173	$P > 0.05$	NO
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	115.79	127.57	-.844	0.399	$P > 0.05$	NO
R/B11	Reducing capital spending (operational costs, overhead production costs)	116.24	120.61	-.309	0.757	$P > 0.05$	NO
R/B12	Using resources effectively	115.65	129.79	-1.012	0.312	$P > 0.05$	NO
R/B13	Building organisation reputation and creating new customer opportunities	116.30	119.57	-.272	0.785	$P > 0.05$	NO
R/B14	Improving process performance continuously from reactive to proactive	115.63	130.00	-1.397	0.162	$P > 0.05$	NO
R/B15	Improving and increasing earnings, profitability and market share	116.53	115.96	-.048	0.965	$P > 0.05$	NO
Reasons for/ Benefits of Six Sigma implementation (mean)		**116.28**	**119.89**	**-.205**	**.837**	**$P > 0.05$**	**NO**

Table 6.30: Mann-Whitney test on reasons for/ benefits of Six Sigma implementation between organisational positions (managerial and operational)

No.	Reasons for/ benefits of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Managerial (N=149)	Operational (N=83)	Z	P	Sig. (2-tailed)	Difference
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	118.35	113.19	-.893	0.372	$P > 0.05$	NO
R/B2	Improving business, financial performance and organisation efficiency	117.71	114.32	-.575	0.565	$P > 0.05$	NO
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	119.57	110.98	-1.253	0.210	$P > 0.05$	NO
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	118.26	113.34	-.702	0.483	$P > 0.05$	NO
R/B5	Gaining competitive advantage	122.52	105.69	-2.291	0.022*	$P < 0.05$	YES
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	118.97	112.07	-1.034	0.301	$P > 0.05$	NO
R/B7	Changing and improving organisation culture	118.49	112.93	-.812	0.417	$P > 0.05$	NO
R/B8	Achieving faster and on-time delivery	118.37	113.15	-.734	0.463	$P > 0.05$	NO
R/B9	Decreasing employee work loads for undesirable work	120.08	110.07	-1.525	0.127	$P > 0.05$	NO
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	116.02	117.36	-.192	0.848	$P > 0.05$	NO
R/B11	Reducing capital spending (operational costs, overhead production costs)	117.20	115.24	-.279	0.780	$P > 0.05$	NO
R/B12	Using resources effectively	117.57	114.58	-.431	0.666	$P > 0.05$	NO
R/B13	Building organisation reputation and creating new customer opportunities	116.57	116.37	-.039	0.974	$P > 0.05$	NO
R/B14	Improving process performance continuously from reactive to proactive	113.68	121.57	-1.544	0.123	$P > 0.05$	NO
R/B15	Improving and increasing earnings, profitability and market share	119.59	110.95	-1.337	0.181	$P > 0.05$	NO
Reasons for/ Benefits of Six Sigma implementation (mean)		**116.67**	**116.19**	**-.055**	**.956**	**$P > 0.05$**	**NO**

* Significant at $P < 0.05$

6.3.1.4.2 Correlation analysis

To determine whether there is correlation (relationship) between the reasons for/ benefits of the Six Sigma implementation programme, correlation analysis test was made as follows.

- *Correlation between reasons/benefits perspective dimensions (tangible and intangible)*

To determine whether there is correlation (relationship) between reasons/benefits perspective dimensions (tangible and intangible), Spearman's rho test was run. Table 6.31 presents the results.

Table 6.31: Correlations between reasons/benefits perspective dimensions (tangible and intangible) (Spearman's rho)

	N=232	Tangible	Intangible
Tangible	Correlation Coefficient	1.000	0.621**
	Sig. (2-tailed).		0.000
Intangible	Correlation Coefficient	0.621**	1.000
	Sig. (2-tailed).	0.000	

** Correlation significant at 0.01 level (2-tailed)

Results shows that the tangible and intangible reasons/benefits affect the implementation of the Six Sigma project and there is a positive medium correlation between the reasons/benefits perspective dimensions (tangible and intangible) (r rho = 0.621 and $P < 0.01$).

6.3.2 Challenges of Six Sigma Implementation (Questionnaire, Section 6)

The purpose of the question of this section is to have the view of respondents on the main challenges of the Six Sigma implementation in the Middle East organisations. The respondents were asked to rate the criticality and the significance of challenges of Six Sigma implementation in their organisations based on their experience against a list of 13 challenges identified through the review of the Six Sigma literature and the pilot study arranged in random order. A five-point Likert scale for criticality and significance (1 = not at all, 2 = less significant, 3 = significant, 4 = very significant and 5 = highly significant) was given for rating each challenge. A detailed description and analysis follows.

6.3.2.1 Reliability analysis

The reliability analysis (internal consistency) for the main challenges of implementation of the Six Sigma programme in the Middle East organisations used item-to-total correlation and Cronbach α for each of the 13 items.

Table 6.32 shows that the item-to-total correlations for all the 13 items (challenges) range from 0.412 to 0.772 and fall into the acceptable level; none was found to be below the acceptable minimum value of 0.30 (see Section 5.9.1), so no item removal was needed to improve scale reliability. It can therefore be concluded that this question of the survey questionnaire instrument has a high internal consistency and is therefore reliable. On the other hand, the overall value of Cronbach α was 0.874, while the values of Cronbach α in Saudi Arabia, Egypt and UAE were 0.871, 0.857 and 0.892, respectively. Since all values are greater than 0.7, the instrument is therefore deemed reliable and should provide the expected results (see Section 5.9.1).

Table 6.32: Reliability (internal consistency) - Cronbach's alpha values of challenges of Six Sigma implementation

No.	Challenges of Six Sigma implementation	Saudi Arabia (N=97)		Egypt (N=72)		UAE (N=63)		**Overall (N=232)**	
		Corrected item-total correlation	Result	Corrected item-total correlation	Result	Corrected item-total correlation	Result	**Corrected item-total correlation**	**Result**
C1	Lack of top management commitment and support	0.448	Accepted	0.528	Accepted	0.514	Accepted	**0.493**	**Accepted**
C2	Lack of communication	0.477	Accepted	0.412	Accepted	0.506	Accepted	**0.462**	**Accepted**
C3	Organisational resistance (fear of change)	0.485	Accepted	0.473	Accepted	0.472	Accepted	**0.475**	**Accepted**
C4	Lack of teamworking	0.483	Accepted	0.442	Accepted	0.502	Accepted	**0.473**	**Accepted**
C5	Lack of resources	0.559	Accepted	0.581	Accepted	0.637	Accepted	**0.590**	**Accepted**
C6	Cost of training and consulting and long time needed for training	0.478	Accepted	0.428	Accepted	0.555	Accepted	**0.485**	**Accepted**
C7	Selecting suitable projects	0.462	Accepted	0.474	Accepted	0.772	Accepted	**0.567**	**Accepted**
C8	Lack of measurement of customer satisfaction	0.751	Accepted	0.614	Accepted	0.694	Accepted	**0.684**	**Accepted**
C9	Lack of rewarding system	0.413	Accepted	0.512	Accepted	0.546	Accepted	**0.489**	**Accepted**
C10	Lack of data availability, collection and analysis	0.730	Accepted	0.599	Accepted	0.725	Accepted	**0.681**	**Accepted**
C11	Insufficient training	0.728	Accepted	0.619	Accepted	0.722	Accepted	**0.685**	**Accepted**
C12	Poor project management	0.510	Accepted	0.455	Accepted	0.472	Accepted	**0.476**	**Accepted**
C13	Lack of implementing statistical tools and techniques	0.510	Accepted	0.606	Accepted	0.561	Accepted	**0.557**	**Accepted**
Cronbach's α value		**0.871**		**0.857**		**0.892**		**0.874**	

6.3.2.2 Descriptive analysis

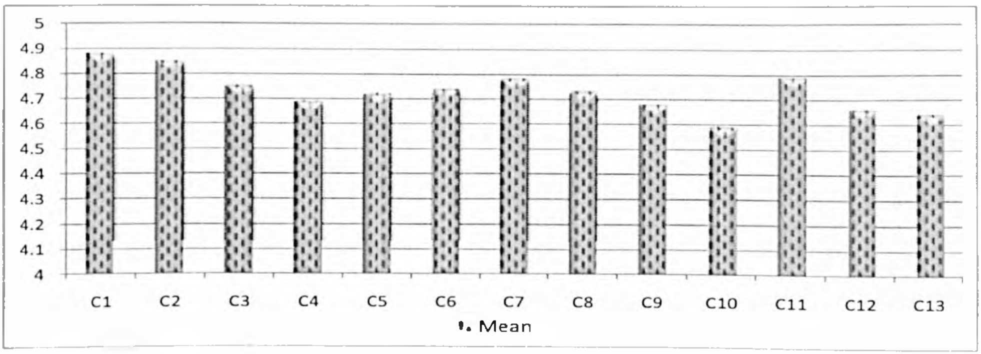
Table 6.33 gives the descriptive statistics analysis of the challenges of the Six Sigma implementation in the Middle East and presents the mean, standard deviation and ranking of each challenge based on the data given by the respondents, while Figure 6.23 represents the results graphically in the form of bar charts.

The results show that all means are high, ranging between 4.59 and 4.87. In addition, there are two items with the same rank. Overall, the most significant challenge was 'the lack of top management commitment and support'; second most significant was 'the lack of communication'. The third highest ranking challenge in Six Sigma implementation in the Middle East was 'selecting suitable projects'. The fourth most important were 'organisational resistance (fear of change)' and 'insufficient training'.

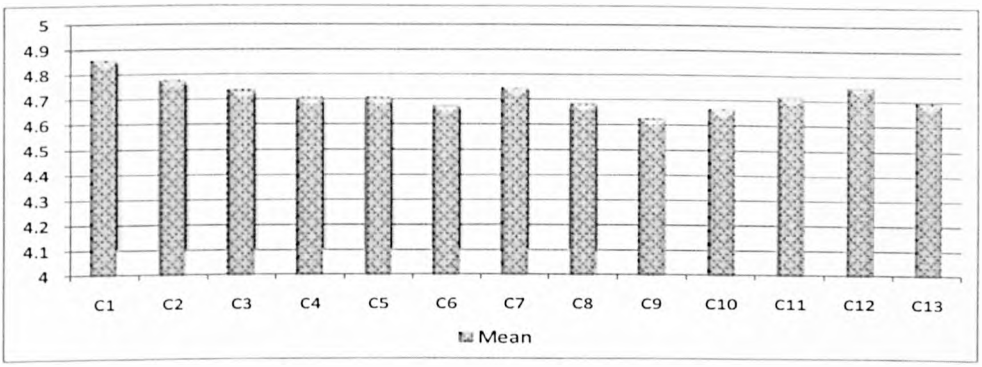
Table 6.33: Descriptive analysis (mean, standard deviation (SD) and ranking) of challenges of Six Sigma implementation

No.	Challenges of Six Sigma implementation	Saudi Arabia (N=97)			Egypt (N=72)			UAE (N=63)			**Overall (N=232)**		
		Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	**Mean**	**SD**	**Rank**
C1	Lack of top management commitment and support	4.88	.391	1	4.86	.348	1	4.90	.336	1	**4.88**	**.374**	**1**
C2	Lack of communication	4.85	.417	2	4.78	.687	2	4.86	.470	3	**4.82**	**.520**	**2**
C3	Organisational resistance (fear of change)	4.75	.523	5	4.74	.581	5	4.83	.383	5	**4.77**	**.507**	**4***
C4	Lack of teamworking	4.69	.584	9	4.71	.492	7*	4.75	.507	8	**4.73**	**.565**	**7**
C5	Lack of resources	4.72	.535	8	4.71	.524	7*	4.69	.521	11	**4.72**	**.547**	**8***
C6	Cost of training and consulting and long time needed for training	4.74	.545	6	4.68	.668	11	4.84	.368	4	**4.75**	**.549**	**6**
C7	Selecting suitable projects	4.78	.484	4	4.75	.496	4	4.87	.336	2	**4.80**	**.453**	**3**
C8	Lack of measurement of customer satisfaction	4.73	.535	7	4.69	.573	10	4.71	.633	10	**4.71**	**.572**	**10**
C9	Lack of rewarding system	4.68	.632	10	4.63	.680	13	4.73	.574	9	**4.68**	**.647**	**12**
C10	Lack of data availability, collection and analysis	4.59	.641	13	4.67	.581	12	4.62	.705	13	**4.63**	**.640**	**13**
C11	Insufficient training	4.79	.432	3	4.72	.610	6	4.79	.446	7	**4.77**	**.496**	**4***
C12	Poor project management	4.66	.694	11	4.76	.537	3	4.68	.714	12	**4.70**	**.653**	**11**
C13	Lack of implementing statistical tools and techniques	4.64	.636	12	4.70	.542	9	4.81	.396	6	**4.72**	**.551**	**8***

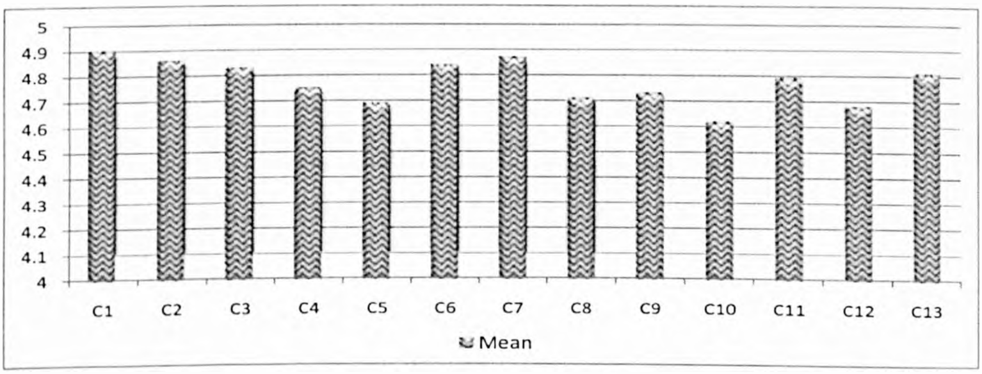
* Another item(s) with same rank (tied rank)



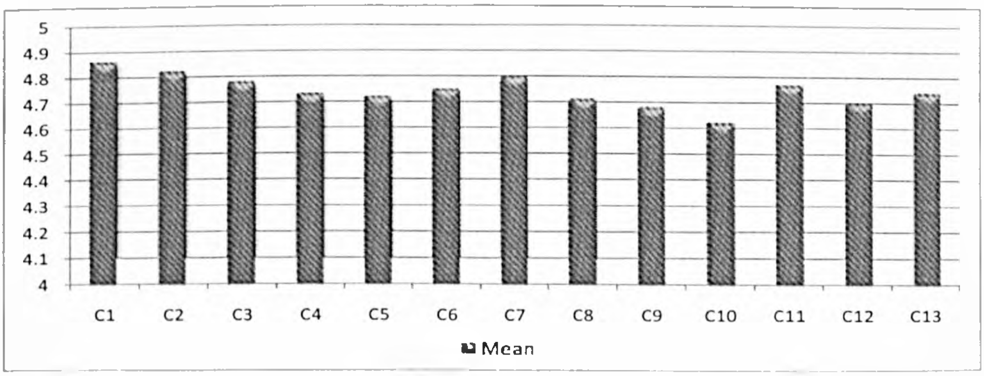
Saudi Arabia



Egypt



UAE



Overall

Figure 6.24: Mean values of challenges of Six Sigma implementation

6.3.2.3 Perspective analysis

The challenges of Six Sigma found in this study can also be analysed from the perspective of managerial and technical challenges. The managerial challenges are issues that impact on an organisation related to the management support and involvement in the implementation of the Six Sigma programme in attaining the organisation's Six Sigma goals. Technical challenges are issues that impact on an organisation related to the technical dimensions. Table 6.34 presents classification of challenges of Six Sigma implementation under both dimensions.

Table 6.34: Classification of challenges of Six Sigma implementation under managerial and technical dimensions

Dimension	C. No.	Challenges of Six Sigma implementation
Managerial	C1	Lack of top management commitment and support
	C2	Lack of communication
	C3	Organisational resistance (fear of change)
	C4	Lack of teamworking
	C6	Cost of training and consulting and long time needed for training
	C7	Selecting suitable projects
	C9	Lack of rewards system
	C11	Insufficient training
	C12	Poor project management
Technical	C5	Lack of resources
	C8	Lack of measurement of customer satisfaction
	C10	Lack of data availability, collection and analysis
	C13	Lack of implementing statistical tools and techniques

6.3.2.4 Statistical analysis

The statistical analysis for this item will use the same analyses as before in the reasons/benefits item for significant difference and correlation as follows.

6.3.2.4.1 Significant difference analysis

To investigate the current status of Six Sigma implementation in the Middle East context, the challenges for the Six Sigma implementation programme in the two perspective dimensions, the three countries, the two sectors, the two sizes on organisations and the two organisational positions will be analysed statistically to find whether there are differences as follows.

- *Differences in challenges between perspective dimensions (managerial and technical)*

For determination of whether there is a difference between the managerial and technical perspective challenges for the Six Sigma implementation programme, a Wilcoxon test was run. Table 6.35 presents the results.

Table 6.35: Wilcoxon test of challenges of Six Sigma implementation between perspective dimensions (managerial and technical)

	Wilcoxon Test							
					Differences (N=232)			
Technical-Managerial		(N=232)	Mean Rank	Sum of Rank	Z	P	Sig. (2-tailed)	Difference
	Negative Rank	63[a]	78.69	4957.00	-4.618[a]	0.026	$P < 0.05$	YES
	Positive Rank	86[b]	92.51	7956.00				
	Tiles	83[c]	---	---				

a. Technical < Managerial, b. Technical > Managerial, c. Technical = Managerial

The results of Table 6.35 confirm that there are highly significant differences ($Z = -4.618$ and $P < 0.05$). The technical challenges generated lower mean rank compared to managerial challenges.

- *Differences in challenges between countries (Saudi Arabia, Egypt and UAE)*

Determination of whether there is a significant difference in the challenges for Six Sigma implementation between the three Middle East countries (Saudi Arabia, Egypt and UAE) was by a Kruskal-Wallis test. Table 6.36 presents the results, which confirm that in all the 13 challenges of Six Sigma implementation there are no significant differences (Chi-squared ranging between 0.049 and 2.426 and $P > 0.05$), nor for the mean of all the challenges (Chi-squared = 3.448 and $P > 0.05$).

- *Differences in challenges between sectors (manufacturing and services)*

To determine whether there is a significant difference in the challenges for Six Sigma programme implementation between the two sectors (manufacturing and services), a Mann-Witney test was made and Table 6.37 presents the results. These confirm that in 11 challenges of Six Sigma implementation there are no significant differences (Z ranging between -0.123 and -1.319 and $P > 0.05$) but there are significant differences ($Z = -2.216$ and $P < 0.01$) ($Z = -0.583$ and $P < 0.01$) for the remaining two challenges, C4 and C13, respectively. For the mean of all the challenges, however, there is no significant difference ($Z = -1.012$ and $P > 0.05$).

- *Differences in challenges between sizes of organisations (large and SME)*

To determine whether there is a difference in the challenges for Six Sigma programme implementation between the two sizes (large organisation and SME), a Mann-Witney test was made. Table 6.38 presents the results which confirm that in all 13 challenges of Six Sigma implementation there are no significant differences (Z ranging between -0.088 and -0.783 and $P > 0.05$). For the mean of all the challenges, there are again no significant differences, ($Z = -0.671$ and $P > 0.05$).

- *Differences in challenges between organisational positions (managerial and operational)*

A Mann-Witney test was also made for a significant difference in the challenges for the Six Sigma implementation programme between the two organisational positions (managerial and operational) and Table 6.39 presents the results. These confirm that in all 13 challenges of Six Sigma implementation there are no significant differences (Z ranging between -0.058 and -1.674 and $P > 0.05$) nor for the mean of all the challenges ($Z = -0.159$ and $P > 0.05$).

Table 6.36: Kruskal-Wallis test of challenges of Six Sigma implementation between countries (Saudi Arabia, Egypt and UAE)

No.	Challenges of Six Sigma implementation	Kruskal-Wallis Test						
		Mean Rank			Differences (N=232)			
		Saudi Arabia (N=97)	Egypt (N=72)	UAE (N=63)	Chi-square	*P*	Sig. (2-tailed)	Difference
C1	Lack of top management commitment and support	116.27	116.03	117.40	.046	0.977	$P > 0.05$	NO
C2	Lack of communication	116.46	113.38	120.12	.922	0.631	$P > 0.05$	NO
C3	Organisational resistance (fear of change)	116.59	114.78	118.33	.172	0.917	$P > 0.05$	NO
C4	Lack of teamworking	117.07	112.62	120.11	.753	0.686	$P > 0.05$	NO
C5	Lack of resources	113.32	119.92	117.49	.642	0.725	$P > 0.05$	NO
C6	Cost of training and consulting and long time needed for training	117.13	114.67	117.62	.167	0.920	$P > 0.05$	NO
C7	Selecting suitable projects	112.93	122.15	115.54	1.495	0.473	$P > 0.05$	NO
C8	Lack of measurement of customer satisfaction	111.51	116.44	124.26	2.426	0.297	$P > 0.05$	NO
C9	Lack of rewarding system	114.94	115.38	120.18	.538	0.764	$P > 0.05$	NO
C10	Lack of data availability, collection and analysis	114.60	116.99	118.87	.287	0.866	$P > 0.05$	NO
C11	Insufficient training	116.93	116.97	115.31	.049	0.976	$P > 0.05$	NO
C12	Poor project management	115.78	111.72	123.06	1.946	0.378	$P > 0.05$	NO
C13	Lack of implementing statistical tools and techniques	115.34	111.97	123.46	2.277	0.320	$P > 0.05$	NO
Challenges of Six Sigma implementation (mean)		**110.13**	**114.11**	**129.04**	**3.448**	**.178**	**$P > 0.05$**	**NO**

Table 6.37: Mann-Whitney test of challenges of Six Sigma implementation between sectors (manufacturing and services)

No.	Challenges of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Manufacturing Sector (N=113)	Services Sector (N=119)	Z	P	Sig. (2-tailed)	Difference
C1	Lack of top management commitment and support	112.39	120.40	-.123	0.123	$P > 0.05$	NO
C2	Lack of communication	113.65	119.21	-.343	0.298	$P > 0.05$	NO
C3	Organisational resistance (fear of change)	111.78	120.98	-1.175	0.167	$P > 0.05$	NO
C4	Lack of teamworking	107.93	124.63	-2.216	0.011**	$P < 0.01$	YES
C5	Lack of resources	117.81	115.26	-1.137	0.721	$P > 0.05$	NO
C6	Cost of training and consulting and long time needed for training	113.90	118.97	-.139	0.407	$P > 0.05$	NO
C7	Selecting suitable projects	114.65	118.26	-.711	0.576	$P > 0.05$	NO
C8	Lack of measurement of customer satisfaction	110.65	122.05	-.148	0.086	$P > 0.05$	NO
C9	Lack of rewarding system	115.05	117.87	-.580	0.647	$P > 0.05$	NO
C10	Lack of data availability, collection and analysis	113.90	118.97	-.642	0.441	$P > 0.05$	NO
C11	Insufficient training	114.13	118.75	-.479	0.481	$P > 0.05$	NO
C12	Poor project management	112.10	120.68	-1.319	0.149	$P > 0.05$	NO
C13	Lack of implementing statistical tools and techniques	108.12	124.46	-.583	0.009**	$P < 0.01$	YES
Challenges of Six Sigma implementation (mean)		**107.81**	**124.75**	**-1.012**	**0.509**	**P > 0.05**	**NO**

** Significant at $P < 0.01$

Table 6.38: Mann-Whitney test of challenges of Six Sigma implementation between sizes of organisation (large and SME)

No.	Challenges of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Large organisation (N=218)	SME (N=14)	Z	*P*	Sig. (2-tailed)	Difference
C1	Lack of top management commitment and support	116.56	115.57	-.091	0.928	$P > 0.05$	NO
C2	Lack of communication	116.56	115.57	-.088	0.930	$P > 0.05$	NO
C3	Organisational resistance (fear of change)	115.87	126.25	-.757	0.449	$P > 0.05$	NO
C4	Lack of teamworking	117.05	107.89	-.655	0.512	$P > 0.05$	NO
C5	Lack of resources	116.37	118.50	-.142	0.887	$P > 0.05$	NO
C6	Cost of training and consulting and long time needed for training	116.16	121.75	-.436	0.663	$P > 0.05$	NO
C7	Selecting suitable projects	116.33	119.11	-.205	0.837	$P > 0.05$	NO
C8	Lack of measurement of customer satisfaction	116.30	119.57	-.234	0.815	$P > 0.05$	NO
C9	Lack of rewarding system	115.15	122.00	-.453	0.650	$P > 0.05$	NO
C10	Lack of data availability, collection and analysis	115.85	126.64	-.783	0.434	$P > 0.05$	NO
C11	Insufficient training	117.02	108.39	-.626	0.531	$P > 0.05$	NO
C12	Poor project management	116.61	114.86	-.133	0.894	$P > 0.05$	NO
C13	Lack of implementing statistical tools and techniques	116.17	121.64	-.439	0.661	$P > 0.05$	NO
Challenges of Six Sigma implementation (mean)		**115.78**	**127.68**	**-.671**	**.502**	**P > 0.05**	**NO**

Table 6.39: Mann-Whitney test of challenges of Six Sigma implementation between organisational positions (managerial and operational)

No.	Challenges of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Managerial (N=149)	Operational (N=83)	Z	*P*	Sig. (2-tailed)	**Difference**
C1	Lack of top management commitment and support	115.69	117.96	-.419	0.675	$P > 0.05$	NO
C2	Lack of communication	115.79	117.78	-.357	0.721	$P > 0.05$	NO
C3	Organisational resistance (fear of change)	117.00	115.60	-.207	0.836	$P > 0.05$	NO
C4	Lack of teamworking	113.30	122.25	-1.290	0.197	$P > 0.05$	NO
C5	Lack of resources	120.94	108.52	-1.674	0.094	$P > 0.05$	NO
C6	Cost of training and consulting and long time needed for training	117.66	114.42	-.510	0.610	$P > 0.05$	NO
C7	Selecting suitable projects	119.66	110.83	-1.314	0.189	$P > 0.05$	NO
C8	Lack of measurement of customer satisfaction	114.58	119.95	-.774	0.439	$P > 0.05$	NO
C9	Lack of rewarding system	118.18	113.48	-.734	0.463	$P > 0.05$	NO
C10	Lack of data availability, collection and analysis	114.38	120.31	-.866	0.387	$P > 0.05$	NO
C11	Insufficient training	116.61	116.31	-.058	0.965	$P > 0.05$	NO
C12	Poor project management	116.98	115.64	-.204	0.838	$P > 0.05$	NO
C13	Lack of implementing statistical tools and techniques	116.19	117.05	-.139	0.889	$P > 0.05$	NO
Challenges of Six Sigma implementation (mean)		**117.00**	**115.60**	**-.159**	**.874**	**$P > 0.05$**	**NO**

6.3.2.4.2 Correlation analysis

To determine whether there is correlation (relationship) between the challenges of the Six Sigma implementation programme, correlation analysis test was made as follows.

- *Correlation between challenges perspective dimensions (managerial and technical)*

To determine whether there is correlation between the managerial and technical perspective challenges of Six Sigma implementation programme, Spearman's rho tests were made. Table 6.40 presents the results.

Table 6.40: Correlation between challenges perspective dimensions (managerial and technical) (Spearman's rho)

	N=232	Managerial	Technical
Managerial	Correlation Coefficient	1.000	.482**
	Sig. (2-tailed).		0.000
Technical	Correlation Coefficient	.482**	1.000
	Sig. (2-tailed).	0.000	

** Correlation significant at 0.01 level (2-tailed)

Results show that the managerial and technical challenges affect the implementation of the Six Sigma project and there is a positive correlation between the challenges perspective dimensions (managerial and technical) (r rho = .482 and $P > 0.05$).

6.3.3 Critical Success Factors for Six Sigma Implementation (Questionnaire, Section 7)

The aim of the question of this section is to gather the view of respondents on the major CSFs for the effective implementation of the Six Sigma programme in the Middle East organisations. Respondents were asked to rate the criticality and the significance of the CSFs of implementation of Six Sigma in their organisations based on a list of 19 CSFs for Six Sigma implementation, identified through a review of the Six Sigma literature and pilot study, arranged in random order. A five-point Likert scale for criticality and significance (1 = not at all, 2 = less significant, 3 = significant, 4 = very significant and 5 = highly significant) was provided against each factor. A detailed description and analysis follows.

6.3.3.1 Reliability analysis

The reliability analysis for the CSFs for the effective implementation of Six Sigma programme in the Middle East organisations used item-to-total correlation and Cronbach alpha (α) for each item (19 items).

Table 6.41 presents the results, which show that the item-to-total correlation for all the 19 items ranges from 0.412 to 0.723, which falls into the acceptable level; none was found to be below the acceptable minimum value of 0.30 (see Section 5.9.1), so no items were removed to improve scale reliability. It can therefore be concluded that this question of the survey questionnaire instrument has a high internal consistency and is therefore reliable. The overall value of Cronbach α was 0.910, while the values in Saudi Arabia, Egypt and UAE were 0.902, 0.916, and 0.924, respectively. With all Cronbach's alphas greater than 0.7, the instrument is therefore deemed reliable and should provide the expected results (see Section 5.9.1).

Table 6.41: Reliability (internal consistency) - Cronbach's alpha values of CSFs for Six Sigma implementation

No.	CSFs for Six Sigma implementation	Saudi Arabia (N=97)		Egypt (N=72)		UAE (N=63)		**Overall (N=232)**	
		Corrected item-total correlation	Result	Corrected item-total correlation	Result	Corrected item-total correlation	Result	**Corrected item-total correlation**	**Result**
F1	Top management commitment and support	0.479	Accepted	0.430	Accepted	0.412	Accepted	**0.444**	**Accepted**
F2	Readiness for cultural change	0.526	Accepted	0.558	Accepted	0.574	Accepted	**0.548**	**Accepted**
F3	Continuous training and education	0.545	Accepted	0.650	Accepted	0.541	Accepted	**0.577**	**Accepted**
F4	Teamwork	0.567	Accepted	0.613	Accepted	0.568	Accepted	**0.578**	**Accepted**
F5	Effective communication	0.479	Accepted	0.552	Accepted	0.711	Accepted	**0.552**	**Accepted**
F6	Formation of Six Sigma organisational structure	0.526	Accepted	0.533	Accepted	0.648	Accepted	**0.588**	**Accepted**
F7	Integrating Six Sigma with customer satisfaction	0.513	Accepted	0.558	Accepted	0.642	Accepted	**0.553**	**Accepted**
F8	Integrating Six Sigma with corporate business strategy	0.531	Accepted	0.646	Accepted	0.575	Accepted	**0.536**	**Accepted**
F9	Integrating Six Sigma with employees	0.487	Accepted	0.508	Accepted	0.648	Accepted	**0.534**	**Accepted**
F10	Integrating Six Sigma with suppliers	0.490	Accepted	0.537	Accepted	0.642	Accepted	**0.544**	**Accepted**
F11	Integrating Six Sigma with financial goals	0.567	Accepted	0.650	Accepted	0.628	Accepted	**0.609**	**Accepted**
F12	Integrating Six Sigma with existing initiatives	0.723	Accepted	0.476	Accepted	0.531	Accepted	**0.597**	**Accepted**
F13	Integrating Six Sigma with rewards and recognition system	0.701	Accepted	0.654	Accepted	0.589	Accepted	**0.654**	**Accepted**
F14	Use of Six Sigma methodologies and tools	0.693	Accepted	0.475	Accepted	0.548	Accepted	**0.583**	**Accepted**
F15	Project management skills	0.533	Accepted	0.589	Accepted	0.541	Accepted	**0.551**	**Accepted**
F16	Project prioritisation, selection, evaluation, tracking and reviews	0.513	Accepted	0.640	Accepted	0.568	Accepted	**0.564**	**Accepted**
F17	Integrating Six Sigma with information technology (IT) infrastructure	0.429	Accepted	0.610	Accepted	0.562	Accepted	**0.513**	**Accepted**
F18	Competitive benchmarking for Six Sigma	0.510	Accepted	0.603	Accepted	0.711	Accepted	**0.580**	**Accepted**
F19	Use of external consultants	0.484	Accepted	0.672	Accepted	0.641	Accepted	**0.577**	**Accepted**
Cronbach's α value		**0.902**		**0.916**		**0.924**		**0.910**	

6.3.3.2 Descriptive analysis

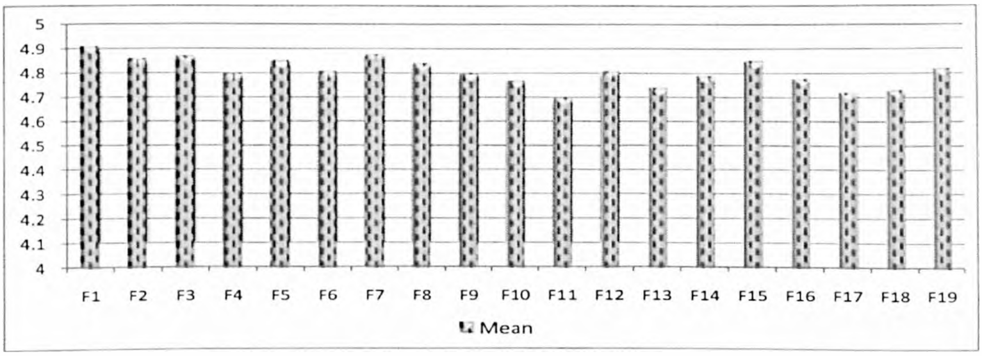
Table 6.42 gives the descriptive statistics analysis of the CSFs for Six Sigma implementation in the Middle East and presents the mean, standard deviation and ranking of each CSF based on the data given by the respondents. Figure 6.25 has a graphical presentation in the form of bar charts.

The results show that all means are high, ranging between 4.64 and 4.91. In addition, there are a few items with the same ranks. Overall, the most significant CSF for Six Sigma implementation in the Middle East was 'top management commitment and support', the second was 'continuous training and education', and the third was 'readiness for cultural change'. In the fourth position came 'integrating Six Sigma with customer satisfaction', while the fifth most significant CSFs were 'integrating Six Sigma with corporate business strategy', 'integrating Six Sigma with existing initiatives' and 'project management skills'.

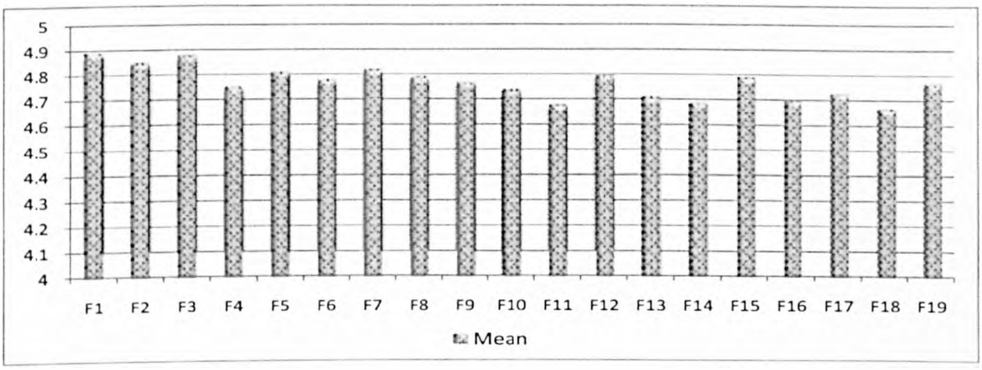
Table 6.42: Descriptive analysis (mean, standard deviation (SD) and ranking) for CSFs for Six Sigma implementation

No.	CSFs of Six Sigma implementation	Saudi Arabia N=97			Egypt (N=72)			UAE (N=63)			**Overall (N=232)**		
		Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	**Mean**	**SD**	**Rank**
F1	Top management commitment and support	4.91	.292	1	4.89	.454	1	4.86	.544	1	**4.88**	**.425**	**1**
F2	Readiness for cultural change	4.86	.389	4	4.85	.362	3	4.83	.552	3*	**4.85**	**.463**	**3**
F3	Continuous training and education	4.87	.399	3	4.88	.430	2	4.84	.522	2	**4.86**	**.448**	**2**
F4	Teamwork	4.80	.448	11*	4.75	.496	12	4.70	.626	17	**4.75**	**.598**	**13***
F5	Effective communication	4.85	.363	5*	4.81	.432	5	4.73	.591	14	**4.80**	**.504**	**8**
F6	Formation of Six Sigma organisational structure	4.81	.441	9*	4.78	.610	9	4.72	.714	15	**4.77**	**.528**	**10***
F7	Integrating Six Sigma with customer satisfaction	4.88	.361	2	4.82	.387	4	4.81	.663	6	**4.83**	**.522**	**4**
F8	Integrating Six Sigma with corporate business strategy	4.84	.405	7	4.79	.409	7*	4.80	.595	7*	**4.81**	**.547**	**5***
F9	Integrating Six Sigma with employees	4.80	.471	11*	4.77	.550	10*	4.78	.682	9	**4.78**	**.558**	**9**
F10	Integrating Six Sigma with suppliers	4.77	.510	15	4.74	.503	13	4.77	.647	10	**4.76**	**.547**	**12**
F11	Integrating Six Sigma with financial goals	4.70	.515	19	4.68	.601	18	4.71	.699	16	**4.70**	**.562**	**18**
F12	Integrating Six Sigma with existing initiatives	4.81	.464	9*	4.80	.409	6	4.83	.490	3*	**4.81**	**.518**	**5***
F13	Integrating Six Sigma with rewards and recognition system	4.74	.587	16	4.71	.473	15	4.82	.465	5	**4.75**	**.591**	**13***
F14	Use of Six Sigma methodologies and tools	4.79	.448	13	4.69	448	17	4.75	.588	12*	**4.74**	**.512**	**15***
F15	Project management skills	4.85	.456	5*	4.79	.529	7*	4.80	.586	7*	**4.81**	**.477**	**5***
F16	Project prioritisation, selection, evaluation, tracking and reviews	4.78	.432	14	4.70	.490	16	4.76	.494	11	**4.74**	**.472**	**15***
F17	Integrating Six Sigma with information technology (IT) infrastructure	4.72	.515	18	4.73	.444	14	4.69	.626	18	**4.71**	**.494**	**17**
F18	Competitive benchmarking for Six Sigma	4.73	.550	17	4.67	.692	19	4.64	.663	19	**4.68**	**.599**	**19**
F19	Use of external consultants	4.82	.400	8	4.77	.510	10*	4.74	.638	13	**4.77**	**.475**	**10***

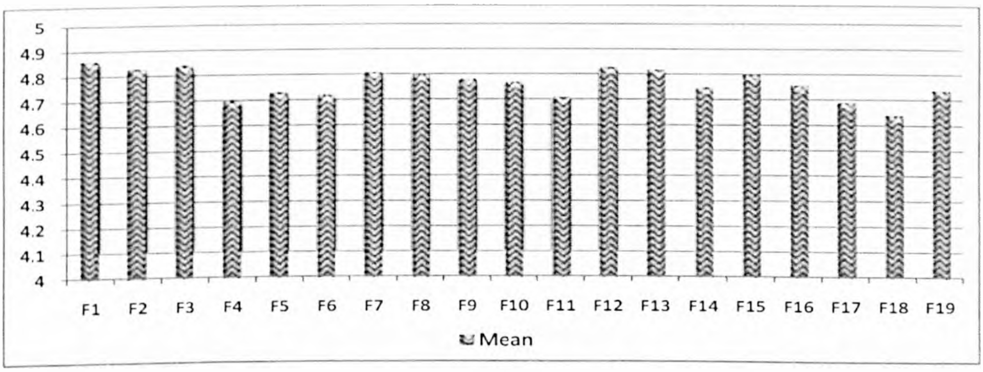
* Another item(s) with same rank (tied rank)



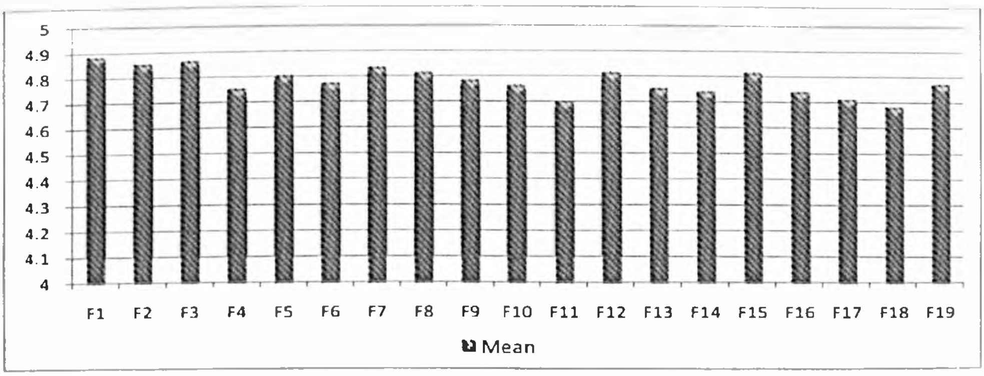
Saudi Arabia



Egypt



UAE



Overall

Figure 6.25: Mean values of CSFs for Six Sigma implementation

6.3.3.3 Perspective analysis

The CSFs of Six Sigma implementation collected in this study can be analysed from the perspective of soft and hard dimensions and can then be placed as three categories: people, organisation and technologies, which have to be kept in mind and dealt with when implementing a Six Sigma programme successfully. The soft factors are issues that impact on maximising organisation-wide support and involvement in the implementation of the Six Sigma programme in attaining the Six Sigma goals of an organisation. They may best be seen as issues discussed under people (culture) and organisation (systems). Hard factors include technologies (skill and tools) techniques that impact on internal efficiency. While the effective management of the soft factors is essential to the achievement of the Six Sigma quality goals of the organisation, they must be supported by the hard factors to manage, track and improve the journey towards achieving the goals. Table 6.43 presents classification of CSFs of Six Sigma implementation under soft (people and organisation) and hard (technologies) dimensions.

Table 6.43: Classification of CSFs of Six Sigma implementation under soft (people and organisation) and hard (technologies) dimensions

Dimension	Category	CSF. No.	CSFs of Six Sigma implementation
Soft	People (Culture)	F1	Top management commitment and support
		F2	Readiness for cultural change
		F3	Continuous training and education
		F4	Teamwork
		F5	Effective communication
	Organisation (Systems)	F6	Formation of Six Sigma organisational structure
		F7	Integrating Six Sigma with corporate business strategy
		F8	Integrating Six Sigma with customer satisfaction
		F9	Integrating Six Sigma with employees
		F10	Integrating Six Sigma with suppliers
		F11	Integrating Six Sigma with financial goals
		F12	Integrating Six Sigma with existing initiatives
		F13	Integrating Six Sigma with rewards and recognition system
Hard	Technologies (Skills and Tools)	F14	Use of Six Sigma methodologies and tools
		F15	Project management skills
		F16	Project prioritisation, selection, evaluation and reviews
		F17	Integrating Six Sigma with IT infrastructure
		F18	Competitive benchmarking for Six Sigma
		F19	Use of external consultants

6.3.3.4 Statistical analysis

The statistical analysis for the CSFs will use the same analyses as before for the reasons/benefits and challenges for the significant difference analysis and correlation analysis as follows.

6.3.3.4.1 Significant difference analysis

To investigate the current status of Six Sigma implementation in the Middle East context, the CSFs for the Six Sigma implementation programme in the two perspective dimensions, the three perspective categories, the three countries, the two sectors, the two organisation sizes and the two organisational positions will be analysed statistically to find whether there are differences as follows.

- *Differences of CSFs between perspective dimensions (soft and hard)*

For determination of whether there is a difference of the CSFs for the Six Sigma implementation programme between the soft and hard perspective dimensions factors, a Wilcoxon test was run. Table 6.44 present results.

Table 6.44: Wilcoxon test of CSFs for Six Sigma implementation between perspective dimensions (soft and hard)

Hard-Soft	Wilcoxon Test							
					Differences (N=232)			
		(N=232)	Mean Rank	Sum of Rank	Z	P	Sig. (2-tailed)	Difference
	Negative Rank	59[a]	67.53	3984.00	-2.467[a]	0.043	P < 0.05	YES
	Positive Rank	85[b]	75.95	6456.00				
	Tiles	88[c]	---	---				

a. Hard < Soft, b. Hard > Soft, c. Hard = Soft

The results of Table 6.44 confirm that there are quiet significant differences ($Z = -2.467$ and $P < 0.05$). The soft CSF dimensions generated higher mean rank compared to hard CSF dimensions.

- *Differences of CSFs between perspective categories (people, organisation and technologies)*

A Friedman test was made to determine whether there is a significant difference of the CSFs for the Six Sigma implementation programme between the people, organisation and technologies categories factors. The results of Table 6.45 confirm that there are highly significant differences (Chi-squared = 8.315 and $P < 0.05$) between the people, organisation and technologies categories factors.

Table 6.45: Friedman test of CSFs for Six Sigma implementation between perspective categories (people, organisation and technologies)

CSFs categories	Friedman Test				
	Mean Rank	Differences (N=232)			
		Chi-squared	P	Sig. (2-tailed)	Difference
People	2.02	8.315	.016	$P < 0.05$	YES
Organisation	1.89				
Technologies	2.09				

* Significant at $P < 0.05$

- *Differences of CSFs between countries (Saudi Arabia, Egypt and UAE)*

To determine whether there is a significant difference of the CSFs for the Six Sigma implementation between the three Middle East countries (Saudi Arabia, Egypt and UAE), a Kruskal-Wallis test was made. Table 6.46 presents the test results, which confirm that in 16 CSFs of Six Sigma implementation there are no significant differences (Chi-squared ranging between 0.29 and 3.057 and $P > 0.05$), but there are significant differences (Chi-squared = 9.426 and $P < 0.01$; Chi-squared = 7.281 and $P < 0.51$; and Chi-squared = 8.831 and $P < 0.05$) for the other three CSFs (F10, F17 and F19), respectively. For the mean of all the CSFs for Six Sigma implementation, there are no significant differences (Chi-squared = 2.584 and $P > 0.05$).

- *Differences of CSFs between sectors (manufacturing and services)*

A Mann-Witney test was used in determining whether there is a significant difference of the CSFs for the Six Sigma implementation programme between the two sectors (manufacturing and services) and Table 6.47 presents the results which confirm that in 17 CSFs of Six Sigma implementation there are no significant differences (Z ranging between -0.095 and -1.571 and $P > 0.05$) but there are significant differences (Z = -2.237 and $P < 0.05$; Z = -2.115 and $P < 0.05$) for the remaining two CSFs (F3 and F19), respectively. For the mean of all the CSFs, there are no significant differences (Z = -0.0793 and $P > 0.05$).

- *Differences of CSFs between sizes of organisation (large and SME)*

For determining whether there is a difference of the CSFs for the Six Sigma implementation programme between the two sizes of organisation (large and SME), a Mann-Witney test was run. Table 6.48 presents the test results, which confirm that in all the 19 CSFs of Six Sigma implementation there are no significant differences (Z ranging between -0.059 and -1.482 and $P > 0.05$). But for the mean of all the CSFs, there are no significant differences (Z = -0.214 and $P > 0.05$).

- *Differences of CSFs between organisational positions (managerial and operational)*

A Mann-Witney test was used to determine whether there is a difference of CSFs for the Six Sigma implementation programme between the two organisational positions (managerial and operational). Table 6.49 presents the results, which confirm that in 18 CSFs of Six Sigma implementation there are no significant differences (Z ranging between -0.009 and -1.568 and $P > 0.05$) but there are significant differences (Z = -2.130 and $P < 0.05$) for the remaining one CSF (F11). For the mean of all the CSFs, there are no significant differences (Z = -0.413 and $P > 0.05$).

Table 6.46: Kruskal Wallis test of CSFs for Six Sigma implementation between countries (Saudi Arabia, Egypt and UAE)

No.	CSFs of Six Sigma implementation	Kruskal Wallis Test						
		Mean Rank			Differences (N=232)			
		Saudi Arabia N=97)	Egypt (N=72)	UAE (N=63)	Chi-squared	P	Sig. (2-tailed)	Difference
F1	Top management commitment and support	119.74	117.01	110.94	1.484	0.476	$P > 0.05$	NO
F2	Readiness for cultural change	120.97	115.66	110.58	2.537	0.281	$P > 0.05$	NO
F3	Continuous training and education	121.39	117.20	108.18	2.546	0.280	$P > 0.05$	NO
F4	Teamwork	117.59	112.30	119.63	.939	0.625	$P > 0.05$	NO
F5	Effective communication	122.53	114.24	109.81	3.057	0.217	$P > 0.05$	NO
F6	Formation of Six Sigma organisational structure	118.61	117.00	112.67	.681	0.711	$P > 0.05$	NO
F7	Integrating Six Sigma with customer satisfaction	114.71	113.68	122.48	1.292	0.524	$P > 0.05$	NO
F8	Integrating Six Sigma with corporate business strategy	116.06	118.17	115.25	.127	0.939	$P > 0.05$	NO
F9	Integrating Six Sigma with employees	118.65	114.90	115.01	.383	0.826	$P > 0.05$	NO
F10	Integrating Six Sigma with suppliers	116.79	127.27	103.74	9.426	0.009**	$P < 0.01$	YES
F11	Integrating Six Sigma with financial goals	122.03	111.65	113.53	2.411	0.300	$P > 0.05$	NO
F12	Integrating Six Sigma with existing initiatives	118.02	116.67	113.97	.331	0.847	$P > 0.05$	NO
F13	Integrating Six Sigma with rewards and recognition system	118.32	113.80	116.79	.369	0.832	$P > 0.05$	NO
F14	Use of Six Sigma methodologies and tools	116.39	117.17	115.90	.029	0.985	$P > 0.05$	NO
F15	Project management skills	123.31	114.35	108.47	4.339	0.114	$P > 0.05$	NO
F16	Project prioritisation, selection, evaluation, tracking and reviews	118.82	118.88	110.21	1.491	0.475	$P > 0.05$	NO
F17	Integrating Six Sigma with information technology (IT) infrastructure	124.36	105.55	116.91	7.281	0.026*	$P < 0.05$	YES
F18	Competitive benchmarking for Six Sigma	120.92	113.69	112.91	2.151	0.341	$P > 0.05$	NO
F19	Use of external consultants	127.31	109.97	107.32	8.831	0.012*	$P < 0.05$	YES
CSFs of Six Sigma implementation (mean)		**124.58**	**109.93**	**111.57**	**2.584**	**0.275**	**$P > 0.05$**	**NO**

* Significant at $P < 0.05$

** Significant at $P < 0.01$

Table 6.47: Mann-Whitney test of CSFs for Six Sigma implementation between sectors (manufacturing and services)

No.	CSFs of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Manufacturing Sector (N=113)	Services Sector (N=119)	Z	P	Sig. (2-tailed)	Difference
F1	Top management commitment and support	118.42	114.68	-.634	0.526	$P > 0.05$	NO
F2	Readiness for cultural change	120.81	112.41	-1.571	0.116	$P > 0.05$	NO
F3	Continuous training and education	124.23	109.16	-2.237	0.025*	$P < 0.05$	YES
F4	Teamwork	116.85	116.16	-.114	0.909	$P > 0.05$	NO
F5	Effective communication	117.58	115.47	-.343	0.731	$P > 0.05$	NO
F6	Formation of Six Sigma organisational structure	120.08	113.10	-1.185	0.236	$P > 0.05$	NO
F7	Integrating Six Sigma with customer satisfaction	115.78	117.18	-.216	0.829	$P > 0.05$	NO
F8	Integrating Six Sigma with corporate business strategy	120.33	112.86	-1.137	0.255	$P > 0.05$	NO
F9	Integrating Six Sigma with employees	116.08	116.90	-.139	0.890	$P > 0.05$	NO
F10	Integrating Six Sigma with suppliers	118.63	114.48	-.711	0.477	$P > 0.05$	NO
F11	Integrating Six Sigma with financial goals	116.03	116.95	-.151	0.880	$P > 0.05$	NO
F12	Integrating Six Sigma with existing initiatives	118.20	114.88	-.580	0.562	$P > 0.05$	NO
F13	Integrating Six Sigma with rewards and recognition system	118.68	114.53	-.642	0.521	$P > 0.05$	NO
F14	Use of Six Sigma methodologies and tools	118.21	114.87	-.577	0.564	$P > 0.05$	NO
F15	Project management skills	120.55	112.65	-1.329	0.184	$P > 0.05$	NO
F16	Project prioritisation, selection, evaluation, tracking and reviews	117.75	115.32	-.387	0.699	$P > 0.05$	NO
F17	Integrating Six Sigma with information technology (IT) infrastructure	117.14	115.89	-.212	0.832	$P > 0.05$	NO
F18	Competitive benchmarking for Six Sigma	116.24	116.75	-.099	0.921	$P > 0.05$	NO
F19	Use of external consultants	123.23	110.11	-2.115	0.034*	$P < 0.05$	YES
CSFs of Six Sigma implementation (mean)		**119.78**	**114.28**	**-0.793**	**0.629**	$\mathbf{P > 0.05}$	NO

* Significant at $P < 0.05$

Table 6.48: Mann-Whitney test of CSFs for Six Sigma implementation between size of organisations (large and SME)

No.	CSFs of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Large organisation (N=218)	SME (N=14)	Z	*P*	Sig. (2-tailed)	Difference
F1	Top management commitment and support	117.42	102.14	-1.235	0.217	$P > 0.05$	NO
F2	Readiness for cultural change	117.08	107.54	-.851	0.395	$P > 0.05$	NO
F3	Continuous training and education	117.21	105.46	-.830	0.406	$P > 0.05$	NO
F4	Teamwork	115.66	129.54	-1.090	0.276	$P > 0.05$	NO
F5	Effective communication	116.55	115.79	-.059	0.953	$P > 0.05$	NO
F6	Formation of Six Sigma organisational structure	116.78	112.07	-.381	0.703	$P > 0.05$	NO
F7	Integrating Six Sigma with customer satisfaction	115.28	135.43	-1.482	0.138	$P > 0.05$	NO
F8	Integrating Six Sigma with corporate business strategy	117.02	108.39	-.626	0.531	$P > 0.05$	NO
F9	Integrating Six Sigma with employees	117.36	103.07	-1.153	0.249	$P > 0.05$	NO
F10	Integrating Six Sigma with suppliers	115.70	128.93	-1.079	0.280	$P > 0.05$	NO
F11	Integrating Six Sigma with financial goals	116.15	122.00	-.456	0.648	$P > 0.05$	NO
F12	Integrating Six Sigma with existing initiatives	116.37	118.57	-.185	0.854	$P > 0.05$	NO
F13	Integrating Six Sigma with rewards and recognition system	115.90	125.86	-.751	0.452	$P > 0.05$	NO
F14	Use of Six Sigma methodologies and tools	115.42	136.50	-1.753	0.080	$P > 0.05$	NO
F15	Project management skills	116.68	113.68	-.241	0.810	$P > 0.05$	NO
F16	Project prioritisation, selection, evaluation, tracking and reviews	115.42	133.32	-1.356	0.175	$P > 0.05$	NO
F17	Integrating Six Sigma with information technology (IT) infrastructure	116.72	113.07	-.295	0.768	$P > 0.05$	NO
F18	Competitive benchmarking for Six Sigma	116.58	115.21	-.127	0.899	$P > 0.05$	NO
F19	Use of external consultants	117.12	106.82	-.790	0.429	$P > 0.05$	NO
CSFs of Six Sigma implementation (mean)		**116.73**	**112.89**	**-0.214**	**0.831**	**$P > 0.05$**	**NO**

Table 6.49: Mann-Whitney test of CSFs for Six Sigma implementation between organisational positions (managerial and operational)

No.	CSFs of Six Sigma implementation	Mann-Whitney Test					
		Mean Rank		Differences (N=232)			
		Managerial (N=149)	Operational (N=83)	Z	*P*	Sig. (2-tailed)	Difference
F1	Top management commitment and support	114.22	120.60	-1.038	.299	$P > 0.05$	NO
F2	Readiness for cultural change	113.51	121.87	-1.500	.134	$P > 0.05$	NO
F3	Continuous training and education	114.68	119.77	-.725	.469	$P > 0.05$	NO
F4	Teamwork	113.16	122.49	-1.476	.140	$P > 0.05$	NO
F5	Effective communication	116.46	116.57	-.018	.986	$P > 0.05$	NO
F6	Formation of Six Sigma organisational structure	116.48	116.54	-.009	.993	$P > 0.05$	NO
F7	Integrating Six Sigma with customer satisfaction	115.87	117.63	-.261	.794	$P > 0.05$	NO
F8	Integrating Six Sigma with corporate business strategy	114.39	120.28	-.860	.390	$P > 0.05$	NO
F9	Integrating Six Sigma with employees	115.76	117.83	-.337	.736	$P > 0.05$	NO
F10	Integrating Six Sigma with suppliers	115.33	118.60	-.536	.592	$P > 0.05$	NO
F11	Integrating Six Sigma with financial goals	111.64	125.22	-2.130	.033*	$P < 0.05$	YES
F12	Integrating Six Sigma with existing initiatives	116.46	116.57	-.017	.986	$P > 0.05$	NO
F13	Integrating Six Sigma with rewards and recognition system	117.34	114.99	-.358	.721	$P > 0.05$	NO
F14	Use of Six Sigma methodologies and tools	115.56	118.19	-.437	.662	$P > 0.05$	NO
F15	Project management skills	116.99	115.61	-.222	.824	$P > 0.05$	NO
F16	Project prioritisation, selection, evaluation, tracking and reviews	114.10	120.81	-1.023	.306	$P > 0.05$	NO
F17	Integrating Six Sigma with information technology (IT) infrastructure	116.55	116.40	-.024	.981	$P > 0.05$	NO
F18	Competitive benchmarking for Six Sigma	113.50	121.89	-1.568	.117	$P > 0.05$	NO
F19	Use of external consultants	116.98	115.64	-.206	.837	$P > 0.05$	NO
CSFs of Six Sigma implementation (mean)		**115.18**	**118.87**	**-0.413**	**0.680**	**$P > 0.05$**	**NO**

* Significant at $P < 0.05$

6.3.3.4.2 Correlation analysis

To determine whether there is correlation (relationship) between the CSFs of the Six Sigma implementation programme, correlation analysis tests were made as follows.

- *Correlation between CSFs perspective dimensions (soft and hard)*

To determine whether there is correlation between CSF perspective dimensions (soft and hard), Spearman's rho test was run. Table 6.50 presents the results.

Table 6.50: Correlation between CSFs perspective dimensions (soft and hard) (Spearman's rho)

	N=232	Soft	Hard
Soft	Correlation Coefficient	1.000	.703**
	Sig. (2-tailed).		0.000
Hard	Correlation Coefficient	.703**	1.000
	Sig. (2-tailed).	0.000	

** Correlation significant at 0.01 level (2-tailed)

Results shows that there is a positive high correlation between the CSF perspective dimensions (soft and hard) (r rho = 0.703 and $P < 0.01$).

- *Correlation between CSFs perspective categories (people, organisation and technologies)*

In determining whether there is correlation between CSFs for the Six Sigma implementation perspective categories, people, organisation and technologies factors, Spearman's rho test was made and Table 6.51 presents the results.

Table 6.51: Correlation between CSFs perspective categories (people, organisation and technologies) (Spearman's rho)

	N=232	People (culture)	Organisation (system)	Technologies (skills and tools)
People (culture)	Correlation Coefficient	1.000	.751**	.646**
	Sig. (2-tailed).		0.000	0.000
Organisation (system)	Correlation Coefficient	.751**	1.000	.704**
	Sig. (2-tailed).	0.000		0.000
Technologies (skills and tools)	Correlation Coefficient	.646**	.704**	1.000
	Sig. (2-tailed).	0.000	0.000	

** Correlation significant at 0.01 level (2-tailed)

Results show that there is a positive high correlation between CSF perspective categories, people, organisation and technologies factors, for people and organisation (r rho = 0.751 and $P < 0.01$), for people and technologies (r rho = 0.646 and $P < 0.01$) and for organisation and technologies (r rho = 0.704 and $P < 0.01$).

- *Correlation between CSF perspective dimensions (soft and hard) and CSF perspective categories (people, organisation and technologies)*

To determine whether there is correlation between CSF perspective dimensions (soft and hard) and CSF perspective categories (people, organisation and technologies), Spearman's rho test was made. Table 6.52 presents the results.

Table 6.52: Correlation between CSF perspective dimensions (soft and hard) and CSF perspective categories (people, organisation and technologies) (Spearman's rho)

Dimension	N=232	People (culture)	Organisation (system)	Technologies (skills and tools)
Soft	Correlation Coefficient	.880**	.958**	.703**
	Sig. (2-tailed).	0.000	0.000	0.000
Hard	Correlation Coefficient	.646**	.704**	1.000
	Sig. (2-tailed).	0.000	0.000	

** Correlation significant at 0.01 level (2-tailed)

The results show that there is a highly positive correlation between CSF perspective dimensions (soft and hard) and CSF perspective categories (people, organisation and technologies). For soft perspective dimension and the three perspective categories, the correlations were r rho = 0.880 and $P < 0.01$, r rho = 0.958 and $P < 0.01$; and r rho = 0.703 and $P < 0.01$, respectively. For the hard perspective dimension and the perspective categories (people and organisation), the correlations were r rho = 0.646 and $P < 0.01$ and r rho = 0.704 and $P < 0.01$, respectively.

- *Correlation between reasons for/benefits of and CSFs*

In determining whether there is correlation between the reasons for/ benefits of and the CSFs for the Six Sigma implementation programme, Spearman's rho test was made. Table 6.53 presents the results.

Table 6.53: Correlation between reasons for/ benefits of and CSFs for Six Sigma implementation (Spearman's rho)

	N=232	CSFs for Six Sigma implementation
Reasons for/ benefits of Six Sigma implementation	Correlation Coefficient	.784**
	Sig. (2-tailed).	0.000

** Correlation significant at 0.01 level (2-tailed)

The results show that there is a highly positive correlation between the reasons for/ benefits of and the CSFs for Six Sigma implementation programme (r rho = 0.784 and $P < 0.01$).

- *Correlation between challenges and CSFs of Six Sigma implementation*

To determine whether there is correlation between the challenges and the CSFs for Six Sigma implementation programme, Spearman's rho test was made and Table 6.54 presents the results.

Table 6.54: Correlation between challenges and CSFs for Six Sigma implementation programme (Spearman's rho)

	N=232	CSFs of Six Sigma implementation
Challenges of Six Sigma implementation	Correlation Coefficient	.852**
	Sig. (2-tailed).	0.000

** Correlation significant at 0.01 level (2-tailed)

The results show that there is a highly positive correlation between the challenges and the CSFs for Six Sigma implementation programme (r rho = 0.852 and $P < 0.01$).

6.3.4 Satisfaction with Six Sigma Implementation (Questionnaire, Section 8)

The aim of the question of this section is to obtain the view of respondents on their level of satisfaction with the results achieved through the Six Sigma programme implementation in their organisations in the Middle East. The respondents were asked to rate the criticality and the significance of level of satisfaction with the results achieved. A detailed description and analysis follows.

6.3.4.1 Descriptive analysis

Table 6.55 presents the descriptive statistics analysis of the respondents' level of satisfaction with success achieved from their Six Sigma projects in the three Middle East countries (Saudi Arabia, Egypt and UAE). It presents the mean and standard deviation based on the data given by the respondents. On the other hand, Figure 6.26 shows the results graphically in the form of bar charts.

Table 6.55: Descriptive analysis (mean and standard deviation (SD)) of satisfaction with results achieved through Six Sigma implementation

	Saudi Arabia (N=97)		Egypt (N=72)		UAE (N=63)		**Overall (N=232)**	
	Mean	SD	Mean	SD	Mean	SD	**Mean**	**SD**
Satisfaction with Six Sigma implementation	4.69	.591	4.74	.521	4.87	.637	**4.76**	**.549**

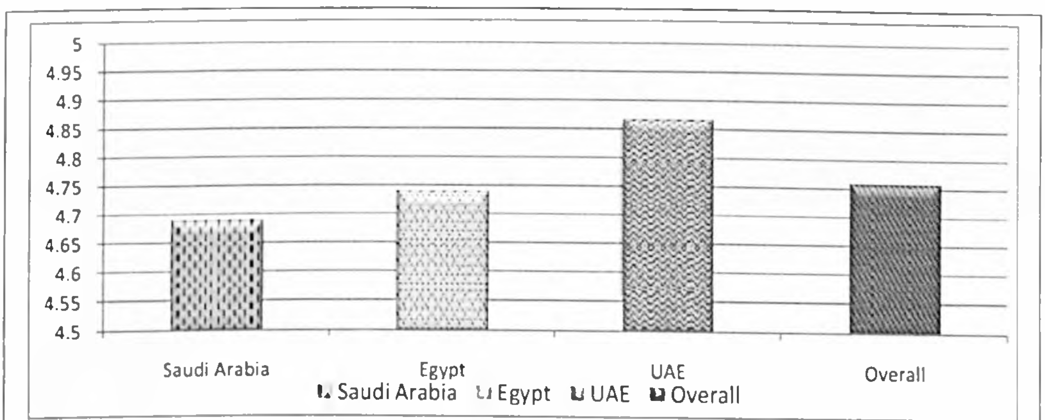


Figure 6.26: Descriptive analysis of satisfaction with results achieved through Six Sigma implementation

In the table and figure, the results show that, overall, most respondents were highly satisfied with project implementation. This implies that, in most cases, the organisations are achieving positive results from Six Sigma implementation.

6.3.4.2 Statistical analysis

The statistical analysis for this item will use the same statistical analysis as before for significant difference and correlation analysis as follows.

6.3.4.2.1 Significant difference analysis

To investigate the current status of Six Sigma implementation in the Middle East context, differences of satisfaction with the programme between the three Middle East countries, the two sectors, the two sizes of organisation and the two organisational positions will be analysed statistically to find whether there is significant difference as follows.

- *Differences of satisfaction between countries (Saudi Arabia, Egypt and UAE)*

Results of a Kruskal-Wallis test to determine whether there is a difference of satisfaction with the results achieved through the Six Sigma programme implementation between the three Middle East countries (Saudi Arabia, Egypt and UAE) are presented in Table 6.56. The results confirm that there are significant differences (Chi-squared = 7.873 and $P > 0.05$) of satisfaction.

Table 6.56: Kruskal Wallis test of satisfaction with Six Sigma implementation between countries (Saudi Arabia, Egypt and UAE)

	Kruskal Wallis Test						
	Mean Rank			Differences (N=232)			
	Saudi Arabia (N=97)	Egypt (N=72)	UAE (N=63)	Chi-squared	P	Sig. (2-tailed)	Difference
Satisfaction with Six Sigma implementation	109.84	112.02	131.87	7.873	0.020*	$P < 0.05$	YES

* Significant at $P < 0.05$

- *Differences of satisfaction between sectors (manufacturing and services)*

A Mann-Witney test was made to determine whether there is difference of the satisfaction with the results achieved through Six Sigma programme implementation between the two sectors (manufacturing and services). Table 6.57 presents the results that confirm significant differences ($Z = -2.762$ and $P < 0.01$) for the satisfaction with the results achieved.

Table 6.57: Mann-Whitney test of satisfaction with Six Sigma implementation between sectors (manufacturing and services

	Mann-Whitney Test					
	Mean Rank		Differences (N=232)			
	Manufacturing (N=113)	Services (N=119)	Z	P	Sig. (2-tailed)	Difference
Satisfaction with Six Sigma implementation	106.97	125.55	-2.762	0.006**	$P < 0.01$	YES

** Significant at $P < 0.01$

- *Differences of satisfaction between sizes of organisation (large and SME)*

To determine the difference of satisfaction with the results achieved through the Six Sigma programme implementation between the two sizes of organisation (large and SME), a Mann-Witney test was run. Table 6.58 presents the results that confirm that there are no significant differences (Z = -1.661 and $P > 0.05$) between the two sizes of organisation, large and SME.

Table 6.58: Mann-Whitney test of satisfaction with Six Sigma implementation between sizes of organisation (large and SME)

	Mann-Whitney Test					
	Mean Rank		Differences (N=232)			
	Large organisation (N=218)	SME (N=14)	Z	P	Sig. (2-tailed)	Difference
Satisfaction with Six Sigma implementation	115.08	138.54	-1.661	0.097	$P > 0.05$	NO

- *Differences of satisfaction between organisational positions (managerial and operational)*

A Mann-Witney test was made to determine whether there is difference in satisfaction between the two organisational positions (managerial and operational) with the results achieved through the Six Sigma programme implementation. Table 6.59 presents the results of the test that confirm that there are no significant differences (Z = -1.112 and $P > 0.05$).

Table 6.59: Mann-Whitney test of satisfaction with Six Sigma implementation between organisational positions (managerial and operational)

	Mann-Whitney Test					
	Mean Rank		Differences (N=232)			
	Managerial (N=149)	Operational (N=83)	Z	P	Sig. (2-tailed)	Difference
Satisfaction with Six Sigma implementation	119.29	111.49	-1.112	0.266	$P > 0.05$	NO

6.3.4.2.2 Correlation analysis

To determine whether there is correlation (relationship) between CSFs and satisfaction for the Six Sigma implementation programme, correlation analysis test was made as follows.

- *Correlation between CSFs and satisfaction of Six Sigma implementation*

To determine whether there is correlation between the CSFs and satisfaction for the Six Sigma implementation programme, Spearman's rho test was made and Table 6.60 presents the results.

Table 6.60: Correlation between CSFs and satisfaction with Six Sigma implementation programme (Spearman's rho)

	N=232	Satisfaction for Six Sigma implementation
CSFs of Six Sigma implementation	Correlation Coefficient	.841**
	Sig. (2-tailed).	0.000

** Correlation significant at 0.01 level (2-tailed)

Table 6.60 shows a highly positive correlation between CSFs and satisfaction for the Six Sigma implementation programme (r rho = 0.841 and $P < 0.01$).

6.3.5 Respondents' Comments (Questionnaire, Section 9)

In this section, the respondents were asked to make any comments they would like to share regarding the Six Sigma programme based on their experience of its implementation in their organisations. The important comments will be considered and discussed in detail in the discussion of findings (Chapter 8) and in the conclusions and recommendations (Chapter 9).

6.4 Chapter Summary

This chapter focused on the description and analysis of the quantitative data collected in this study using a survey strategy with 232 questionnaires in 44 organisations in three Middle East countries in order to get a better understanding of the current status of Six Sigma in the Middle East context. It provided a brief account of the profile and background of the respondents' samples surveyed in the study by giving the demographic data (characteristics of respondents and their organisations) of the current research. Furthermore, it provided a detailed description and analysis of each question of the research questionnaire. Descriptive statistics gave more details about the data and the items/questions. All items were ranked based on the Mean and that helped in understanding which particular item was rated highly in comparison with others. In addition, it gave the researcher an indicator of how satisfied the respondents are in relation to each item. Justification and explanation of differences among the different variables will be discussed in detail in Chapter 8. The next chapter, on qualitative data analysis, will provide an analysis of the research interviews. Further discussion and interpretation of the findings of the research will be presented in Chapter 8.

CHAPTER 7

QUALITATIVE DATA ANALYSIS

CHAPTER 7

QUALITATIVE DATA ANALYSIS

7.1 Introduction

This chapter concerns the analysis of the qualitative data from the research interviews (74 semi-structured interviews from 37 Middle East organisations). The presentation follows the same pattern as for the quantitative data analysis in Chapter 6. There are two main parts. The first part (Section 7.2) consists of analysis of the demographic data (characteristics of interviewees and their organisations) which gives background information on the interviewees. The aim here is to provide a brief profile of the interviewees' samples in the study. Demographic details are initially classified into five sub-sections: interviewees' organisations (Section 7.2.1), individual interviewees (Section 7.2.2), Six Sigma programme (Section 7.2.3), Six Sigma implementation (Section 7.2.4) and interviewees' comments (Section 7.2.5).

The second part (Section 7.3) considers an essential part of the analysis of the qualitative data. It focuses on and analyses the data collected from the interview related to the research questions regarding the Six Sigma implementation, the reasons for/ benefits of Six Sigma implementation, (Section 7.3.1), the challenges of implementation (Section 7.3.2), the CSFs for implementation (Section 7.3.3) and the satisfaction with implementation of Six Sigma in the Middle East (Section 7.3.4). The chapter ends with a summary. Figure 7.1 shows the structure of the chapter.

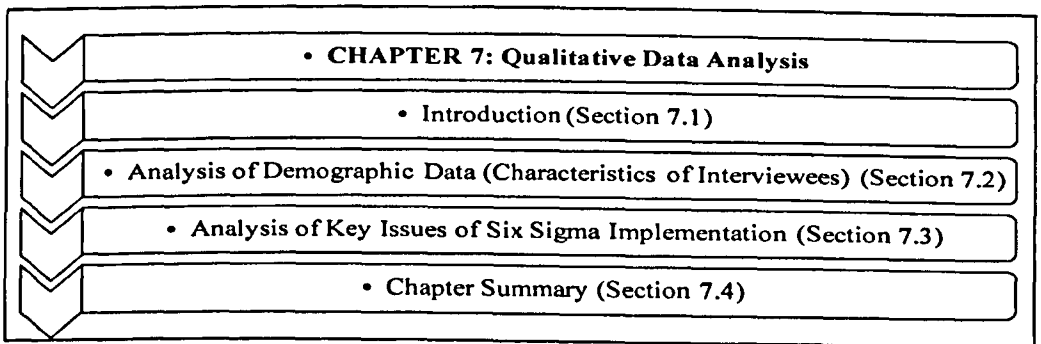


Figure 7.1: Structure of Chapter 7

7.2 Analysis of Demographic Data (Characteristic of Interviewees)

The following sub-sections provide a detailed description and analysis of the demographic data (characteristics of interviewees and their organisations) obtained from the interviews. The analysis follows the interviews sequence of questions.

7.2.1 Profile of Interviewees' Organisations (Interview, Section 1)

This profile aims to give information on the background of the interviewees' organisations. The descriptive analysis includes organisation names, location by country, sector and size according to the number of employees, each item will be covered by a detailed description and analysis.

7.2.1.1 Names of organisations (Section 1, Question 1)

This optional question was asked to determine the willingness of the interviewees to provide the names of their organisations for the study. Table 7.1 and Figure 7.2 present details.

Table 7.1: Names of interviewees' organisations

	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Willing to provide names	10	66.66	6	54.55	9	81.82	**25**	**67.57**
Not willing to provide names	5	33.33	5	45.45	2	18.18	**12**	**32.43**
Total	15		11		11		**37**	

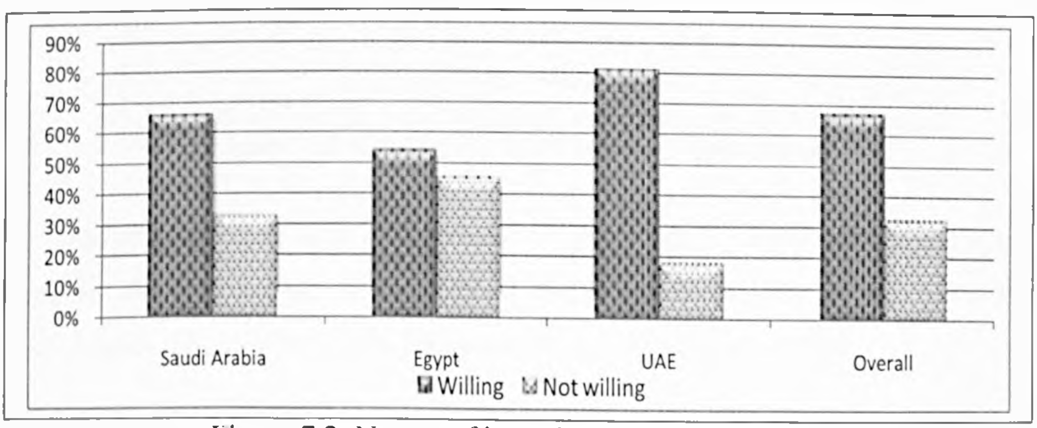


Figure 7.2: Names of interviewees' organisations

In the table and figure, it can be seen that not all interviewees' organisations were willing to give their names. In Saudi Arabia, interviewees' organisations willing to provide their names numbered 10 (66.66%), while there were 5 (33.33%) unwilling; in Egypt, 6 (54.55%) and 5 (45.45%); in UAE, 9 (81.82%) and 2 (18.18%), respectively. Overall, 25 (67.57%) the majority of the interviewees' organisations were willing to provide their names, while there were 12 (32.43%) not willing in all three countries.

7.2.1.2 Country of organisations (Section 1, Question 2)

This question was asked to enable classification of the country of interviewees' organisations, whether in Saudi Arabia, Egypt or UAE. Table 7.2 and Figure 7.3 present details.

Table 7.2: Country of interviewees' organisations

	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Country of interviewees' organisations	15	40.54	11	29.73	11	29.73	**37**	**100**

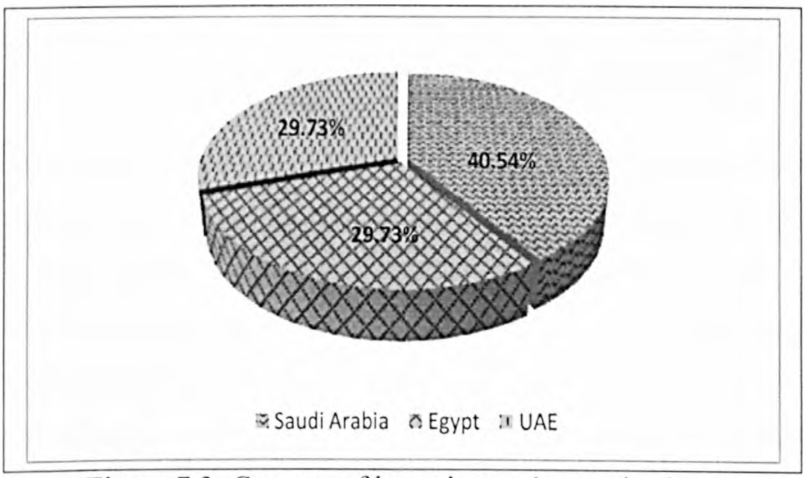


Figure 7.3: Country of interviewees' organisations

The table and figure show that interviewees came from 37 organisations in the three countries. Their geographical breakdown and percentages were 15 (40.54%) from Saudi Arabia, 11 (29.73%) from Egypt and 11 (29.73%) from UAE.

7.2.1.3 Sectors of organisations (Section 1, Question 3)

This question was used to classify interviewees' organisations by their sector or industry (manufacturing or services). Table 7.3 and Figure 7.4 present details.

Table 7.3: Sectors of interviewees' organisations

Sector	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Manufacturing	7	46.66	7	63.64	3	27.27	**17**	**45.95**
Services	8	53.33	4	36.36	8	72.73	**20**	**54.05**
Total	15		11		11		**37**	

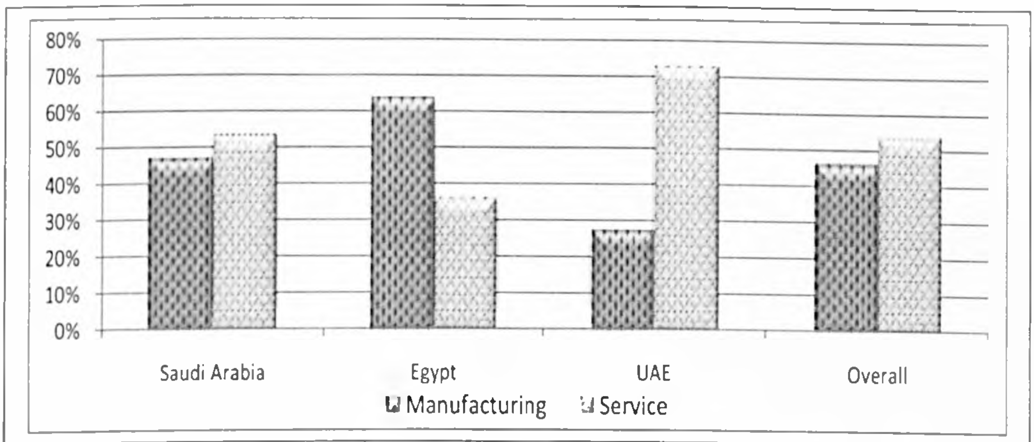


Figure 7.4: Sectors of interviewees' organisations

As can be seen from the table and figure, interviewees' organisations were in both the manufacturing and services sectors. Regarding industrial sectors, in Saudi Arabia, the manufacturing sector make up 46.66% (7) of organisations while the services sector organisations make up 53.33% (8). In Egypt, the manufacturing sector has 63.64% (7) and the services sector has 36.36% (4). Then, in UAE, the manufacturing sector has 27.27% (3) with 72.73% (8) in the services sector. Overall, services organisations comprise 54.05% (20) of the sample of interviewees' organisations, then 45.95% (17) were manufacturing organisations (see Appendix H, Table H1, for more details).

7.2.1.4 Size of organisations by number of employees (Section 1, Question 4)

This question allowed classification of the size of interviewees' organisations by the number of their employees (large organisations or SMEs). In the current study, size refers to the number at the time of the study, as defined by the Commission of the European Communities (2003): SMEs have fewer than 250 employees and large organisations have more than 250. Tables 7.4 and 7.5 and Figure 7.5 present the data.

Table 7.4: Size of interviewees' organisations by number of employees

Size	Saudi Arabia		Egypt		UAE		Overall	
	No of organisations	%	No of organisations	%	No. of organisations	%	**No. of organisations**	**%**
SME (≤ 250)	---	---	1	9.09	1	9.09	**2**	**5.41**
Large organisation (> 250)	15	100	10	90.91	10	90.91	**35**	**94.59**
Total	15		11		11		**37**	

Table 7.5: Number of employees of interviewees' organisations

Size	No. of employees	Saudi Arabia		Egypt		UAE		Overall	
		No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
SME (≤ 250)	51-150	---	---	---	---	1	9.09	**1**	**2.70**
	151-250	---	---	1	9.09	---	---	**1**	**2.70**
Large organisation (> 250)	251-500	1	6.67	2	18.18	3	27.27	**6**	**16.22**
	501-1000	1	6.67	3	27.27	4	36.36	**8**	**21.62**
	1001-2500	3	20.00	1	9.09	1	9.09	**5**	**13.51**
	2501-5000	5	33.33	2	18.18	2	18.18	**9**	**24.32**
	5001-10000	3	20.00	2	18.18	---	---	**5**	**13.51**
	> 10000	2	13.33	---	---	---	---	**2**	**5.41**
Total		15		11		11		**37**	

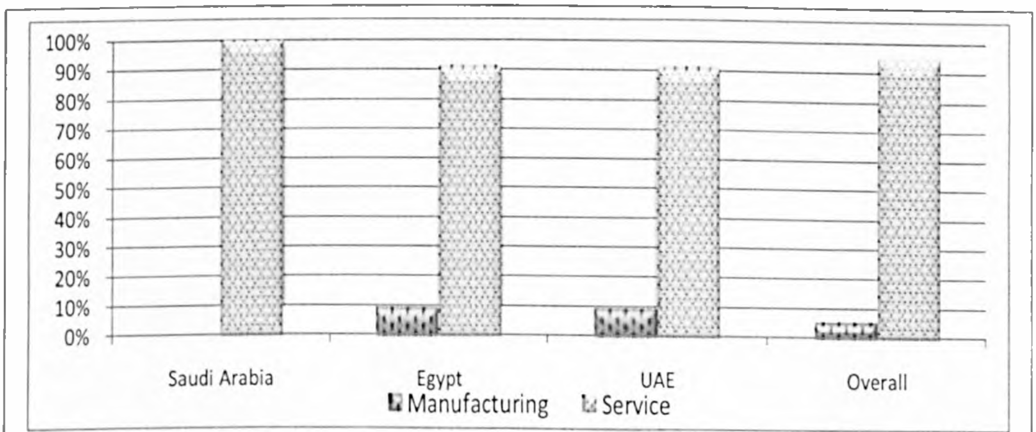


Figure 7.5: Size of interviewees' organisations by number of employees

The tables and figure show that the sample organisations represented by interviewees were large organisations and SMEs. In Saudi Arabia, the large ones with more than 250 employees represent 100% (15). This indicates that Six Sigma is implemented only in the large organisations. But in Egypt and UAE, 90.91% (10) are large and only 9.09% (1) is on SME (fewer than 250 employees), indicating that Six Sigma has been adopted by the large organisations more than by the SMEs in those two countries. Overall, large organisations represent the majority, 94.59% (35), of respondent organisations against 5.41% (2) for SMEs (see Appendix H - Table H2 - for more details).

7.2.2 Profile of Individual Interviewees (Interview, Section 2)

This profile intends to provide a background of the individual interviewees. It includes names of interviewees, nationalities, organisational positions, Six Sigma roles, length of service in the organisation, length as Six Sigma certified/qualified and involvement in Six Sigma implementation projects. Each point will be described in full detail and analysis as follows.

7.2.2.1 Names of interviewees (Section 2, Question 1)

This optional question asked the interviewees whether they were willing to provide their names for the study. Table 7.6 and Figure 7.6 present details.

Table 7.6: Provision of name by interviewees

	Saudi Arabia		Egypt		UAE		**Overall**	
	No of interviewees	%	No. of interviewees	%	No of interviewees	%	**No. of interviewees**	**%**
Willing to provide their names	16	64.00	14	53.85	17	73.91	**47**	**63.51**
Not willing to provide their names	9	36.00	12	46.15	6	26.09	**27**	**36.49**
Total	25		26		23		**74**	

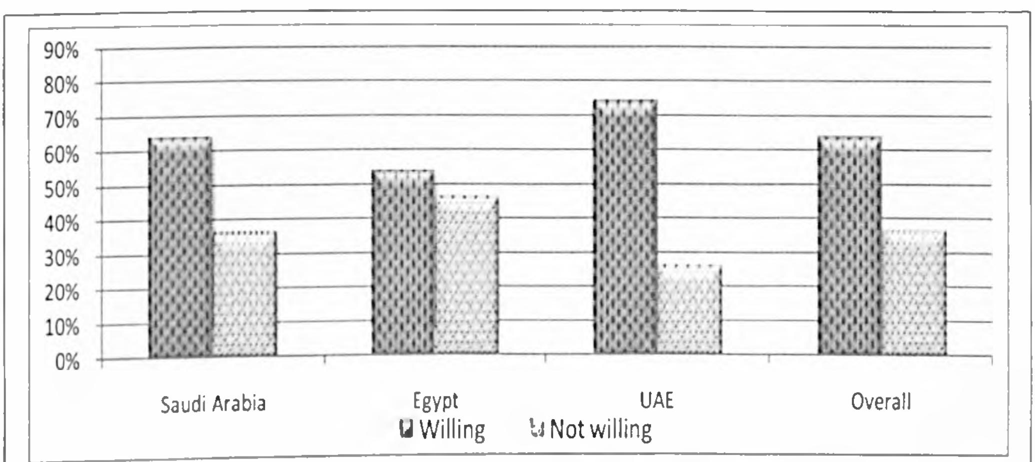


Figure 7.6: Provision of names by interviewees

From the table and figure, we can see the willingness of interviewees to provide their names. In Saudi Arabia, those willing amounted to 16 (64.00%), and there were 9 (36%) not willing; in Egypt, 14 (53.85%) and 12 (46.15%); in UAE, 17 (73.91%) and 6 (26.09%), respectively. Overall, the majority of those willing to provide their names totalled 47 (63.51%), while 27 (36.49%) were not willing, for all the three countries.

7.2.2.2 Nationality of interviewees (Section 2, Question 2)

This question was used to determine interviewees' nationalities (nationals or non-nationals). Table 7.7 and Figure 7.7 present details.

Table 7.7: Nationality of interviewees

	Saudi Arabia		Egypt		UAE		**Overall**	
	Saudi	Non-Saudi	Egyptian	Non-Egyptian	UAE	Non-UAE	**National**	**Non-national**
No. of interviewees	11	14	26	---	4	19	**41**	**33**
%	44.00	56.00	100.00	---	17.39	82.61	**55.41**	**44.59**
Total	25		26		23		**74**	

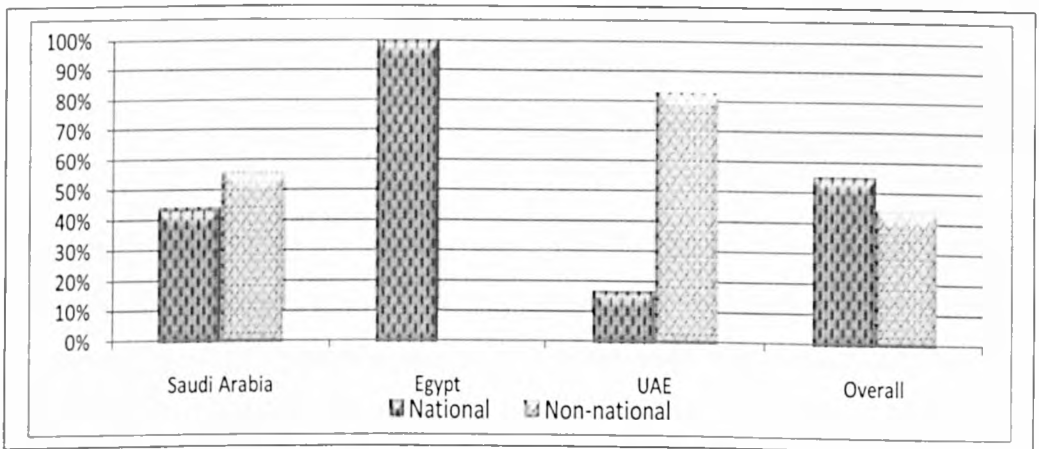


Figure 7.7: Nationality of interviewees

The table and figure show nationalities of interviewees. In Saudi Arabia, Saudi represented 44.00% (11 interviewees), while Non-Saudi represented 56.00% (14). In Egypt, Egyptian represented 100% (26). In UAE, UAE represented 17.39% (4), while Non-UAE represented 82.61% (19). Overall, we can see that nationals are 55.41% (41) and non-nationals are 44.59% (33) of the total interviewees.

7.2.2.3 *Position of interviewees (Section 2, Question 3)*

This question was used to classify the interviewees according to their organisational position (managerial or operational) in their organisations. Table 7.8 and Figure 7.8 present details.

Table 7.8: Organisational position of interviewees

Organisational position	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**
Managerial	15	60.00	17	65.38	13	56.52	**45**	**60.81**
Operational	10	40.00	9	34.62	10	43.48	**29**	**39.19**
Total	25		26		23		**74**	

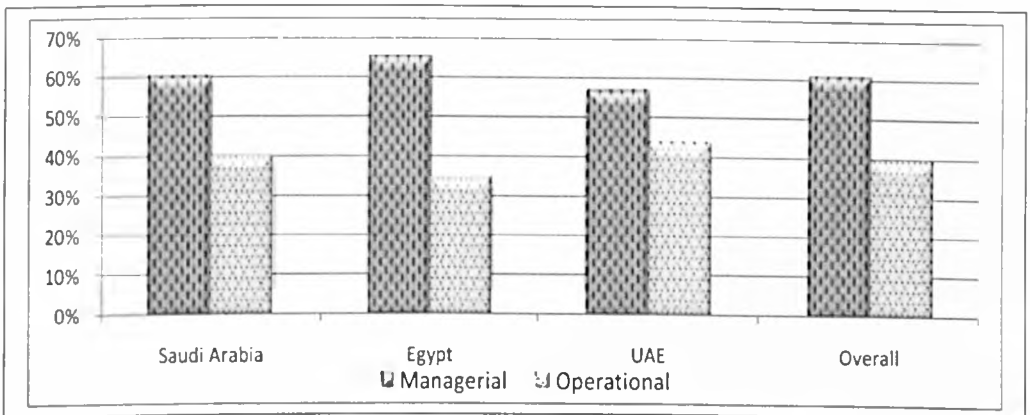


Figure 7.8: Organisational position of interviewees

In the table and figure, it can be seen that the study interviewees held both organisational positions, managerial and operational. In Saudi Arabia, managerial represented 60.00% (15 interviewees), while operational represented 40.00% (10); in Egypt, 65.38% (17) and 34.62% (9); in UAE, 56.52% (13), and 43.48% (10), respectively. Overall, the interviewees holding managerial positions constituted 60.81% (45) and 39.19% (29) held operational positions in all three countries.

7.2.2.4 Six Sigma role of interviewees (Section 2, Question 4)

This question enabled classification of interviewees according to their Six Sigma role (top management executive manager, quality manager, Six Sigma Champion, MBB, BB and GB) in their organisations. Table 7.9 and Figure 7.9 show details.

Table 7.9: Six Sigma role of interviewees

Six Sigma role	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**
Top management executive manager	2	8.00	2	7.70	2	8.69	**6**	**8.11**
Quality manager	1	4.00	2	7.70	1	4.34	**4**	**5.40**
Six Sigma Champion	1	4.00	---	---	1	4.34	**2**	**2.70**
Master Black Belt (MBB)	5	20.00	6	23.07	6	30.43	**17**	**22.97**
Black Belt (BB)	10	40.00	11	42.31	9	39.13	**30**	**40.54**
Green Belt (GB)	6	24.00	5	19.23	4	17.39	**15**	**20.27**
Total	25		26		23		**74**	

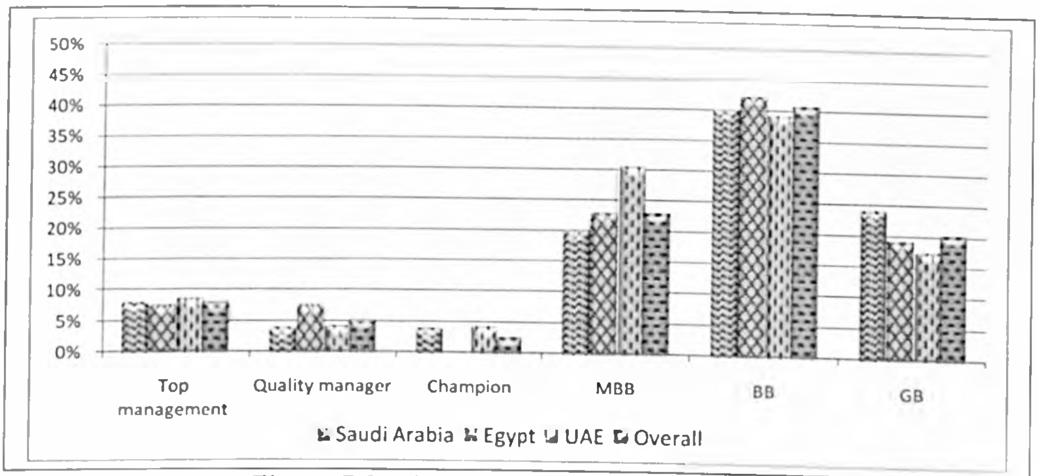


Figure 7.9: Six Sigma role of interviewees

As the table and figure show, the interviewees cover all Six Sigma roles: top management executive managers (CEOs, general managers), quality managers, Six Sigma Champions, MBBs, BBs and GBs. Overall, the majority of interviewees were 30 BBs, representing 40.54% of all interviewees, followed by 17 MBBs with 22.97%. Then, 15 GBs represented 20.27% and 6 top management executive managers represented 8.11% of the interviewees and only 4 (5.40%) and 2 (2.70%) were quality managers and Champions, respectively.

7.2.2.5 Length of service of interviewees (Section 2, Question 5)

This question asked about the length of time served in the organisations. Table 7.10 and Figure 7.10 present details.

Table 7.10: Length of service of interviewees

Years in organisation	Saudi Arabia		Egypt		UAE		**Overall**	
	No of interviewees	%	No of interviewees	%	No of interviewees	%	**No. of interviewees**	**%**
< 2	---	---	2	7.70	3	13.04	**5**	**6.76**
< 4	3	12.00	4	15.38	6	26.09	**13**	**17.57**
< 6	3	12.00	2	7.70	3	13.04	**8**	**10.81**
< 8	5	20.00	7	26.92	6	26.09	**18**	**24.32**
< 10	8	32.00	6	23.07	3	13.04	**17**	**22.97**
> 10	6	24.00	5	19.23	2	8.70	**13**	**17.57**
Total	25		26		23		**74**	

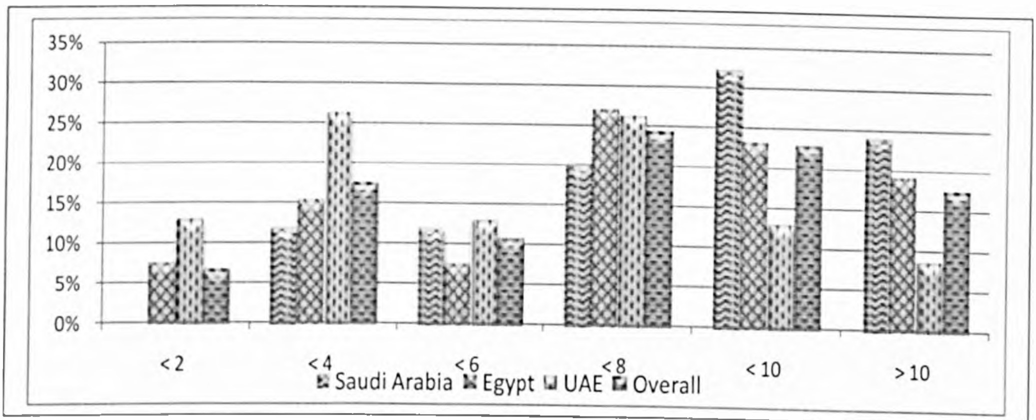


Figure 7.10: Length of service of interviewees

The table and figure show that, overall, 18 (24.32%) of the interviewees have been working in their organisations for fewer than 8 years, followed by 17 (22.97%) for fewer than 10 years. Then, 13 (17.57%) for fewer than 4 years and also 13 (17.57%) for more than 10 years, followed by 8 (10.81%) for fewer than 6 years and just 5 (6.76%) for fewer than 2 years.

7.2.2.6 *Time as Six Sigma certified/qualified of interviewees (Section 2, Question 6)*

This question was used to ask the interviewees about their length of time as Six Sigma certified/qualified or familiar with it. Table 7.11 and Figure 7.11 present details.

Table 7.11: Time as Six Sigma certified/qualified of interviewees

Years as Six Sigma certified/qualified	Saudi Arabia		Egypt		UAE		Overall	
	No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**
< 2	3	12.00	2	7.70	---	---	**5**	**6.76**
< 4	4	16.00	2	7.70	1	4.35	**7**	**9.46**
< 6	7	28.00	8	30.77	10	43.48	**25**	**33.78**
< 8	5	20.00	6	23.08	6	26.09	**17**	**22.97**
< 10	4	16.00	5	19.23	4	17.39	**13**	**17.57**
> 10	2	8.00	3	11.54	2	8.69	**7**	**9.46**
Total	25		26		23		**74**	

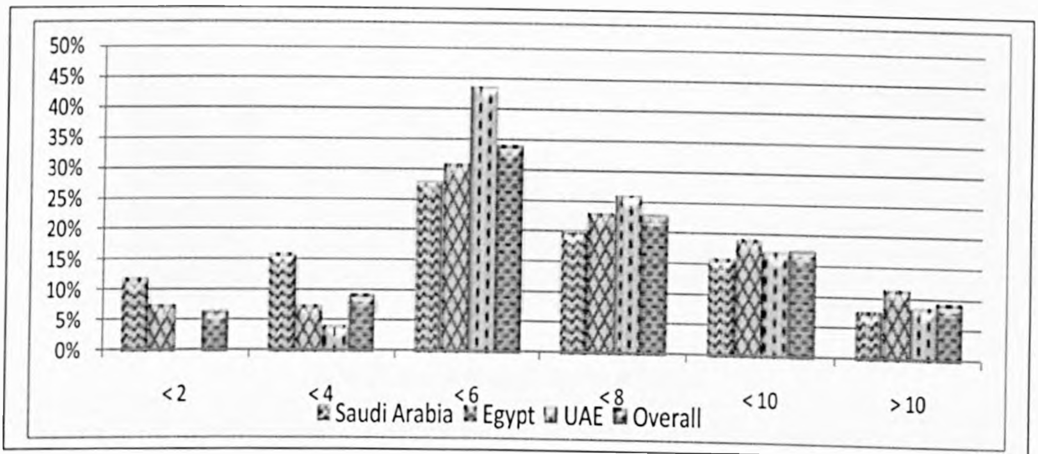


Figure 7.11: Time as Six Sigma certified/qualified of interviewees

As the table and figure show, overall, the majority 25 (33.78%) of interviewees were Six Sigma certified/qualified with between 4 and 6 years' experience, followed by 17 (22.97%) with between 6 and 8 years. Then 13 (17.57%) had been certified/qualified with between 8 and 10 years' experience, whereas only 7 (9.46%) of interviewees were certified/qualified with between 2 and 4 years and 7 (9.46%) for more than 10 years; finally, 5 (6.76%) had fewer than 2 years' experience.

7.2.2.7 Involvement of interviewees in Six Sigma implementation projects of interviewees (Section 2, Question 7)

Involvement in Six Sigma projects in their organisations was revealed by interviews in answering this question. Table 7.12 and Figure 7.12 present details.

Table 7.12: Involvement of interviewees in Six Sigma implementation projects

No. of projects involved	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**
1 – 10	12	48.00	10	38.46	7	30.44	**29**	**39.19**
11 - 20	7	28.00	6	23.08	12	52.17	**25**	**33.78**
21 - 30	6	24.00	7	26.92	3	13.04	**16**	**21.62**
31 - 40	---	---	3	11.54	1	4.35	**4**	**5.41**
40+	---	---	---	---	---	---	---	---
Total	25		26		23		**74**	

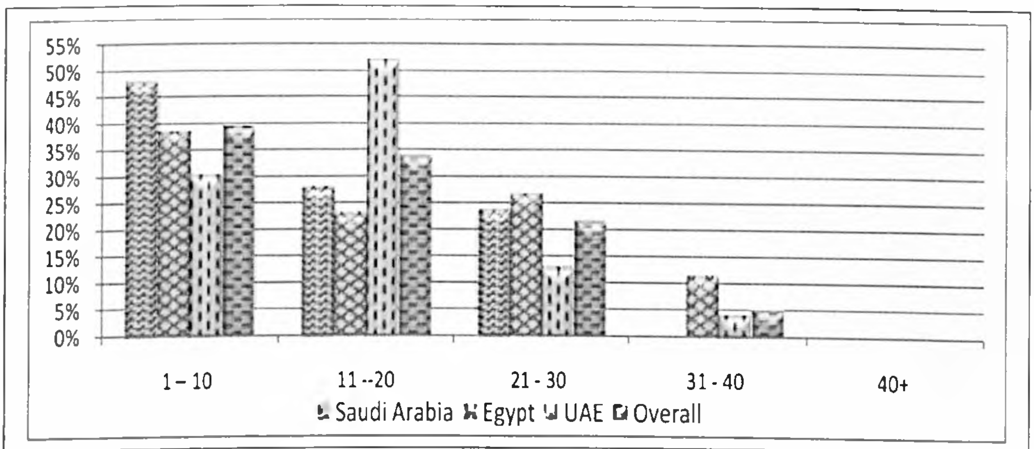


Figure 7.12: Involvement of interviewees in Six Sigma implementation projects

The table and figure show involvement of interviewees in Six Sigma implementation projects in their organisations. Overall, 29 (39.19%) were involved in between 1 and 10 projects, 25 (33.78%) in 11 to 20 and 16 (21.62%) in 21 to 30. Finally, only 4 (5.41%) were involved in between 31 and 40 projects.

7.2.3 Profile of Six Sigma Programme (Interview, Section 3)

This profile aims to present an outline of the Six Sigma programme in the interviewees' organisations such as when the Six Sigma programme was started, who were the primary responsible of the programme in the organisation and what other quality improvement programmes were already implemented when the Six Sigma programme started. Each point is presented and described in full detail and analysis as follows.

7.2.3.1 Time of starting Six Sigma programme (Section 3, Question 1)

This question aimed to discover when the Six Sigma programme was initiated in the interviewees' organisations. Table 7.13 and Figure 7.13 present the results.

Table 7.13: Starting time of Six Sigma programme

Programme start	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No. of organisations	%	No of organisations	%	**No. of organisations**	**%**
< 10 years	2	13.33	1	9.09	---	---	**3**	**8.11**
< 7 years	4	26.67	3	27.27	4	36.36	**11**	**29.73**
< 5 years	6	40.00	2	18.18	4	36.36	**12**	**32.43**
< 3 years	3	20.00	3	27.27	2	18.18	**8**	**21.62**
< 1 year	---	---	2	18.18	1	9.09	**3**	**8.11**
Total	15		11		11		**37**	

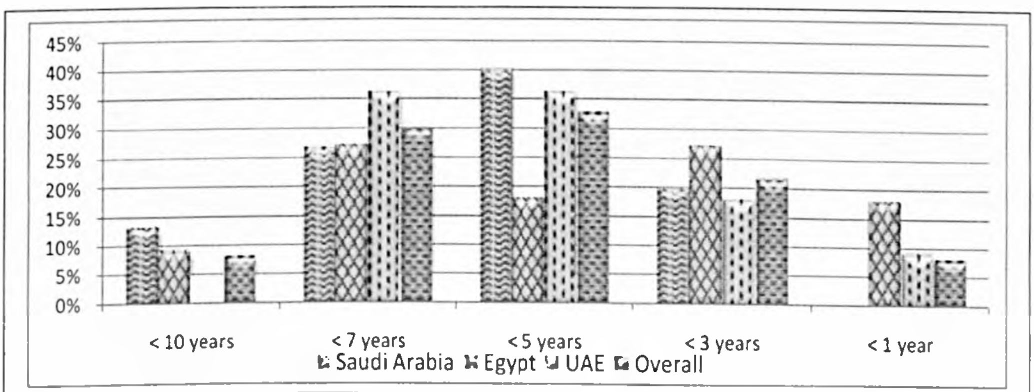


Figure 7.13: Starting time of Six Sigma programme

The table and figure show that, overall, 12 (32.43%) interviewees' organisations started during or after 2004 and 11 (29.73%) during or after 2002. In addition, 8 (21.62%) started during or after 2005 and only 3 (8.11%) during or after 2008. Finally, 3 (8.11%) of the organisations in this study have been using Six Sigma during or after 1999.

7.2.3.2 Primary responsible of Six Sigma programme (Section 3, Question 2)

In this question, interviewees were asked who was the primary responsible of the Six Sigma programme in their organisations. Table 7.14 and Figure 7.14 present details.

Table 7.14: Primary responsible of Six Sigma programme

Primary responsible	Saudi Arabia		Egypt		UAE		**Overall**	
	No of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
CEO	3	20.00	2	18.18	2	18.18	**7**	**18.92**
Director	4	26.67	3	27.27	1	9.09	**8**	**21.62**
General manager	2	13.33	1	9.09	2	18.18	**5**	**13.51**
Manager	2	13.33	2	18.18	1	9.09	**5**	**13.51**
External consultant	4	26.67	3	27.27	5	45.45	**12**	**32.43**
Total	15		11		11		**37**	

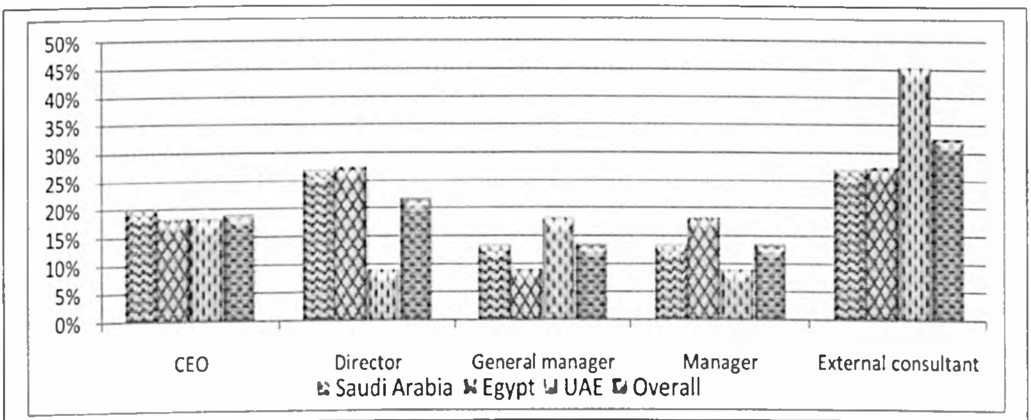


Figure 7.14: Primary responsible of Six Sigma programme

The table and figure indicate that, overall, in 32.43% of cases (12 organisations), external consultants were the primary responsible, directors in 21.62% (8), followed by CEO in 18.92% (7) and, finally, both general managers and managers in 13.51% (5) of cases each.

7.2.3.3 *Previous quality improvement programmes implemented (Section 3, Question 3)*

This question aimed to reveal what other quality initiatives had been implemented or were being implemented at the time of initiation of the Six Sigma programme in responding organisations. Table 7.15 and Figure 7.15 show the results.

Table 7.15: Previous quality improvement programmes implemented

Programme	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
TQM	14	93.33	11	100.00	11	100.00	**36**	**97.30**
ISO-9000	12	80.00	11	100.00	11	100.00	**34**	**91.89**
BPR	10	66.66	7	63.63	8	72.72	**25**	**67.57**
Benchmarking	9	60.00	10	90.90	11	100.00	**30**	**81.08**
Total	15		11		11		37	

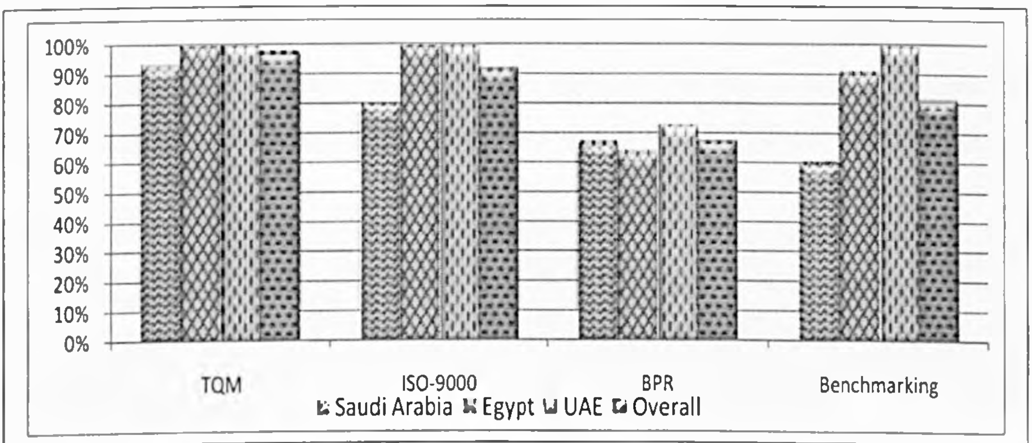


Figure 7.15: Previous quality improvement programmes implemented

In the table and figure, it can be seen that, overall, 97.30% (36 organisations) had implemented TQM before implementing Six Sigma, while 91.89% (34) had implemented ISO-9000, 81.08% (30) Benchmarking and 67.57% (25) BPR quality improvement programme.

7.2.4 Profile of Six Sigma Implementation (Interview, Section 4)

The aim of this profile was to give an idea of the Six Sigma implementation in the interviewees' organisations. It includes the present status of Six Sigma implementation, current pre-DMAIC and DMAIC stages of implementation, number of Six Sigma projects implemented, completion time of Six Sigma projects implemented, percentage of employees involved in Six Sigma projects, level of organisational resistance to the Six Sigma programme and importance of the use of external consultants in the planning and implementation of Six Sigma in the organisations. Each point of this profile is described with full detail and analysis as follows.

7.2.4.1 Present status of Six Sigma implementation (Section 4, Question 1)

This question aimed to discover the present status of the Six Sigma implementation in the interviewees' organisations. Table 7.16 and Figure 7.16 show the findings.

Table 7.16: Present status of Six Sigma implementation

Status of implementation	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Full	3	20.00	4	36.36	7	63.64	**14**	**37.84**
Partial (DMAIC)	10	66.66	6	54.55	4	36.36	**20**	**54.05**
Starting (Pre-DMAIC)	2	13.34	1	9.09	---	---	**3**	**8.11**
Total	15		11		11		**37**	

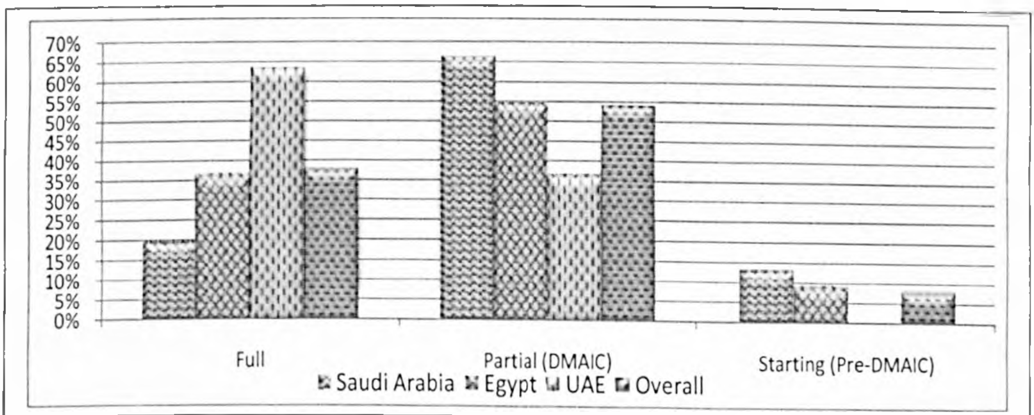


Figure 7.16: Present status of Six Sigma implementation

Overall, 37.84% (14) of the interviewees' organisations have fully implemented Six Sigma projects, 54.05% (20) have partially implemented and 8.11% (3) are at the starting stage of Six Sigma implementation.

7.2.4.2 *Current pre-DMAIC and DMAIC stages of Six Sigma implementation (Section 4, Question 2)*

This question asked the interviewees, in the cases where the Six Sigma programme was not yet fully implemented, which pre-DMAIC and DMAIC stages of Six Sigma their organisation was in. Table 7.17 and Figure 7.17 show the findings.

Table 7.17: Current pre-DMAIC and DMAIC stages of Six Sigma implementation

Stage		Saudi Arabia		Egypt		UAE		**Overall**	
		No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
Starting (Pre-DMAIC)	Planning	---	---	---	---	---	---	**---**	**---**
	Training	1	6.67	1	9.09	---	---	**2**	**5.41**
	Start-up	1	6.67	---	---	---	---	**1**	**2.70**
Partial (DMAIC)	Define	2	13.33	1	9.09	---	---	**3**	**8.11**
	Measure	1	6.67	---	---	1	9.09	**2**	**5.41**
	Analyse	2	13.33	2	18.18	2	18.18	**6**	**16.22**
	Improve	2	13.33	2	18.18	---	---	**4**	**10.81**
	Control	2	13.33	1	9.09	1	9.09	**4**	**10.81**
	Review	1	6.67	---	---	---	---	**1**	**2.70**
Total		12		7		4		**23**	
		15		11		11		**37**	

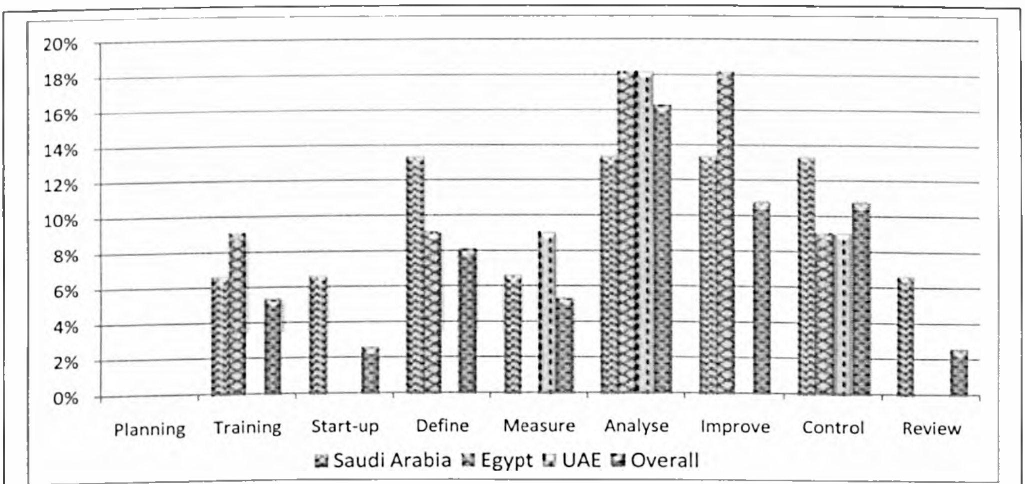


Figure 7.17: Current pre-DMAIC and DMAIC stages of Six Sigma implementation

It can be seen that, overall, in the pre-DMAIC stages, no organisations were in the planning stage, 8.70% (2) were in the training stage and 4.35% (1) were in the start-up stage. In addition, in the DMAIC stage, 13.04% (3) were in the define stage, 8.70% (2) in the measure stage, 26.09% (6) in the analyse stage, 17.40% (4) in the improve stage, 17.40% (4) in the control stage and, finally, 4.35% (1) in the review stage.

7.2.4.3 Number of Six Sigma projects implemented (Section 4, Question 3)

In this question, interviewees were asked how many Six Sigma projects had been implemented so far in their organisations. Table 7.18 and Figure 7.18 give details.

Table 7.18: Number of Six Sigma projects implemented

Projects	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
1 - 5	3	20.00	1	9.09	---	---	**4**	**10.81**
6 - 10	5	33.33	3	27.27	4	36.36	**12**	**32.43**
11 - 15	4	26.67	5	45.45	1	9.09	**10**	**27.03**
16 - 25	1	6.67	---	---	5	45.45	**6**	**16.22**
26 - 40	2	13.33	2	18.18	1	9.09	**5**	**13.51**
40+	---	---	---	---	---	---	---	---
Total	15		11		11		**37**	

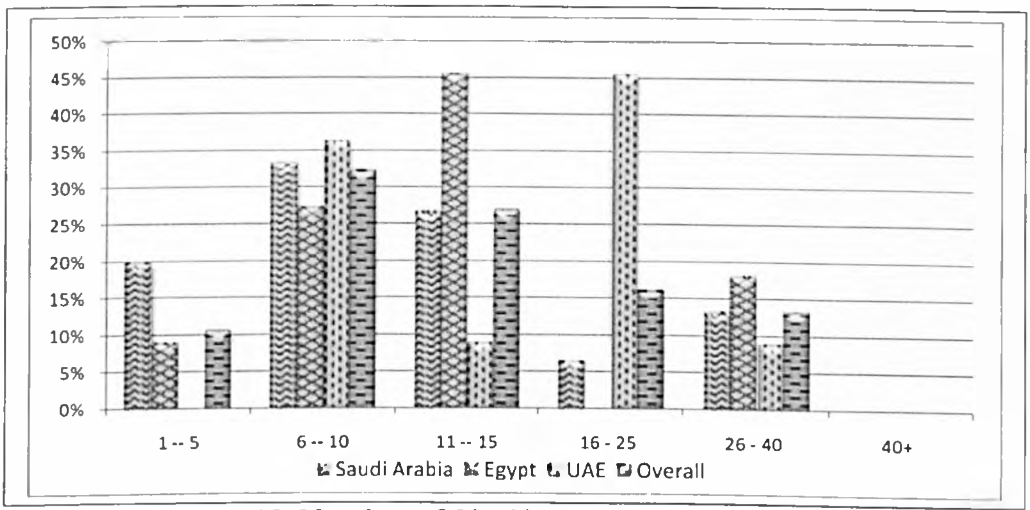


Figure 7.18: Number of Six Sigma projects implemented

Overall, 32.43% (12 organisations) had implemented 6-10 projects, 27.03% (10) had implemented 11-15 projects. 16.22% (6) had 16-25 projects, 13.51% (5) had 26-40 projects and 10.81% (4) had implemented only 1-5 projects. No organisation so far had implemented more than 40 projects.

7.2.4.4 Completion time of Six Sigma projects (Section 4, Question 4)

This question asked the interviewees about the completion time of Six Sigma projects implemented in their organisations. Table 7.19 and Figure 7.19 show the findings.

Table 7.19: Completion time of Six Sigma projects

Months	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
1 - 4	4	26.67	2	18.18	1	9.09	**7**	**18.92**
5 - 8	9	60.00	5	45.45	8	72.73	**22**	**59.46**
9 - 12	1	6.67	3	27.27	2	18.18	**6**	**16.22**
13 - 15	1	6.67	1	9.09	---	---	**2**	**5.41**
15+	---	---	---	---	---	---	---	---
Total	15		11		11		**37**	

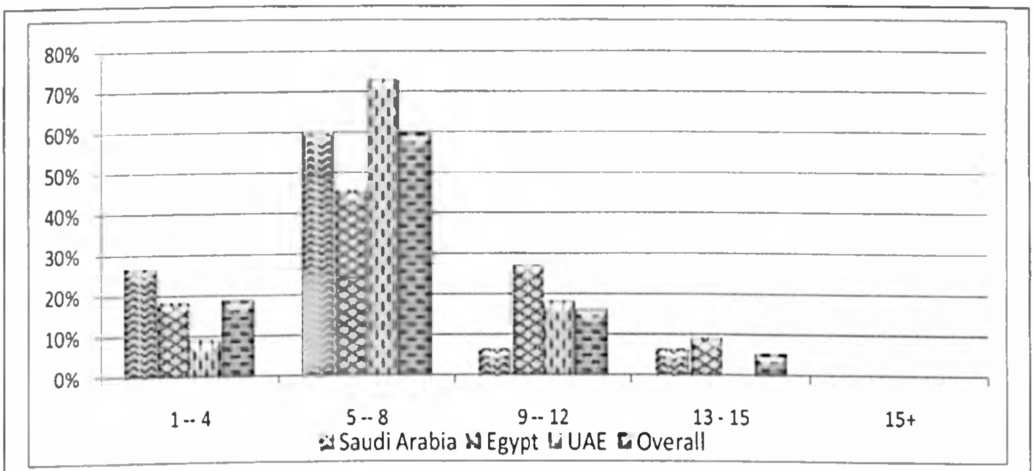


Figure 7.19: Completion time of Six Sigma projects

Overall, the majority, 22 (59.46%), of interviewees' organisations completed their Six Sigma projects in 5-8 months, 7 (18.92%) in 1-4 months, 6 (16.22%) in 9-12 months and just 2 (5.41%) needed more than a year (13-15 months) to complete a project.

7.2.4.5 *Employee involvement (Section 4, Question 5)*

In this question, the interviewees were asked about the percentage of employees involved in Six Sigma project implementation in their organisations. Table 7.20 and Figure 7.20 give details.

Table 7.20: Percentage of employees involved in Six Sigma projects

% Employees	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
1 - 20%	6	40.00	4	36.36	6	54.54	**16**	**43.24**
21 - 30%	7	46.66	4	36.36	2	18.18	**13**	**35.15**
31 - 40%	1	6.67	3	27.27	3	27.27	**7**	**18.92**
41 - 50%	1	6.67	---	---	---	---	**1**	**2.70**
> 50%	---	---	---	---	---	---	---	---
Total	15		11		11		**37**	

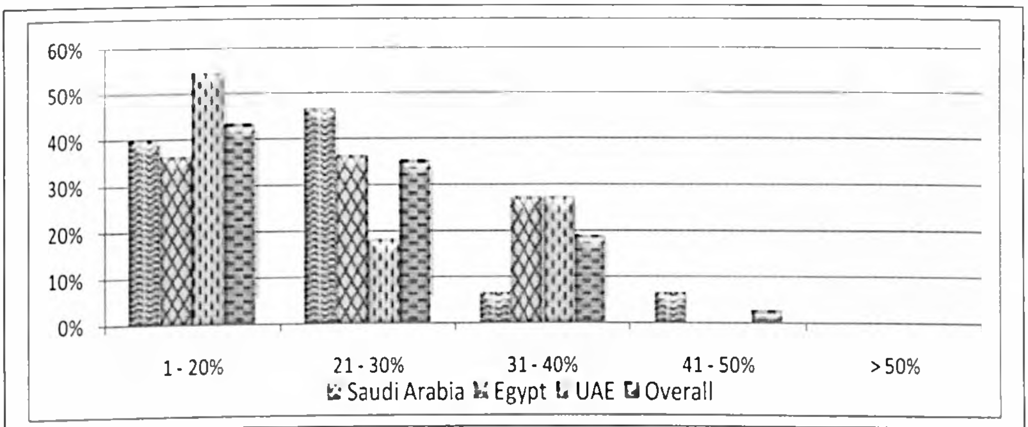


Figure 7.20: Percentage of employees involved in Six Sigma projects

Overall, 43.24% (16 organisations) involved 1-20% of their employees in the Six Sigma projects, while 35.15% (13) involved 21-30%. In addition, 18.92% (7) involved 31-40%, while only 2.70% (1) involved 41-50% of its employees in the Six Sigma projects and no organisation involved more than 50%.

7.2.4.6 Organisational resistance to Six Sigma programme (Section 4, Question 6)

In this interview question, interviewees were asked about the level of organisational resistance to the Six Sigma programme in their organisations. Table 7.21 and Figure 7.21 give details.

Table 7.21: Level of organisational resistance to Six Sigma programme

Resistance level	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of organisations	%	No. of organisations	%	No. of organisations	%	**No. of organisations**	**%**
No resistance	12	80.00	10	90.91	10	90.91	**32**	**86.49**
Minor resistance	2	13.33	---	---	---	---	**2**	**5.40**
Moderate resistance	1	6.67	1	9.09	1	9.09	**3**	**8.11**
Major resistance	---	---	---	---	---	---	---	---
Great resistance	---	---	---	---	---	---	---	---
Total	15		11		11		**37**	

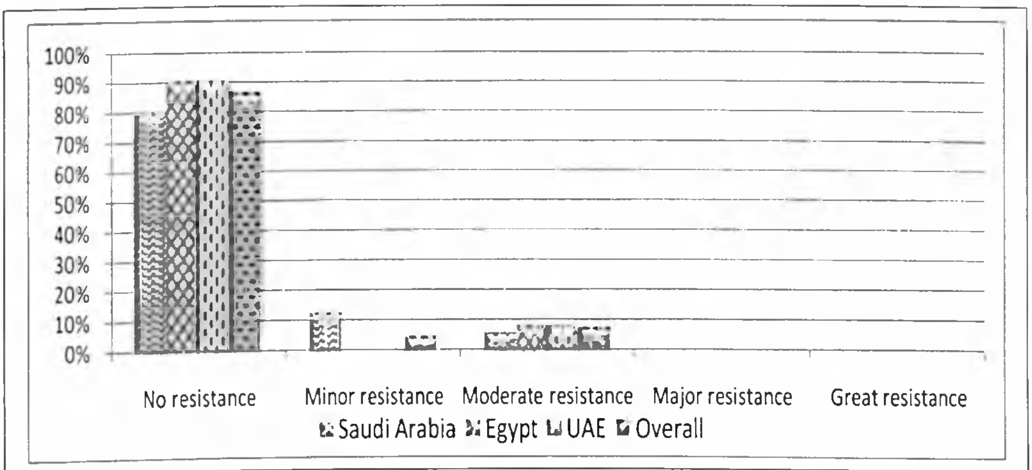


Figure 7.21: Level of organisational resistance to Six Sigma programme

Overall, in most cases, 86.49% (32 organisations), there was no organisational resistance at all, 5.40% (2) had minor resistance, while the rest, 8.11% (3), had moderate resistance and there was no major resistance in any organisation.

7.2.4.7 Importance of use of external consultants (Section 4, Question 7)

This question asked about the importance of the use of external consultants in the planning and implementation of Six Sigma in the organisations. Table 7.22 and Figure 7.22 show the findings.

Table 7.22: Importance of use of external consultants

Importance	Saudi Arabia		Egypt		UAE		**Overall**	
	No of respondents	%	No of respondents	%	No. of respondents	%	**No. of respondents**	**%**
Very important	18	72.00	17	65.38	20	86.94	**55**	**74.32**
Important	6	24.00	7	26.92	3	13.04	**16**	**21.62**
Neutral	1	4.00	2	7.69	---	---	**3**	**4.05**
Not important	---	---	---	---	---	---	---	---
Not at all	---	---	---	---	---	---	---	---
Total	25		26		23		**74**	

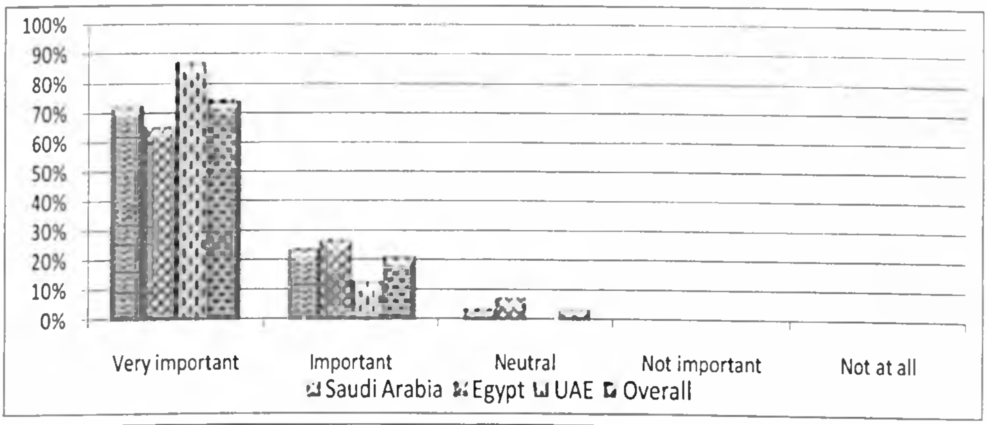


Figure 7.22: Importance of use of external consultants

The table and figure show that in Saudi Arabia, 18 (72.00%) interviewees see the use of external consultants to assist them in implementing Six Sigma as very important, 6 (24.00%) see it as important and only 1 (4.00%) sees it as neutral. In Egypt, 17 (65.38%) see it as very important, while 7 (26.92%) see it as important and 2 (7.69%) see it as neutral. In the UAE, 20 (86.94%) see the use of external consultants as very important, while the remaining 3 (13.04%) see it as important. Overall, the majority of the sample, 55 (74.32%) of interviewees, see the use of external consultants as very important, 16 (21.62%) see it as important and only 3 (4.05%) see it as neutral.

7.3 Analysis of Key Issues of Six Sigma Implementation

The following sub-sections provide a detailed description and analysis of each research question as outlined in Section 1.4, together with illustrative quotations from interviewees' responses. There are four key issues related to Six Sigma implementation in the Middle East organisations in the present research: reasons for/ benefits of Six Sigma implementation, challenges of Six Sigma implementation, CSFs of Six Sigma implementation and, finally, the level of organisations' satisfaction with the implementation of Six Sigma. The qualitative analysis for each question will include tabular data presentation and interviewees' quotations. Although all the interviewees in the three countries (Appendix F) answered all those questions, most replied with points but without any explanation. However, the researcher will present quotations of explanations provided by some interviewees from different sectors, sizes of organisation, occupations and countries to show the range of views. The analysis follows the interview sequence of questions with their sections in brackets.

7.3.1 Reasons for/ Benefits of Six Sigma Implementation (Interview, Section 5)

The aim of the question of this section was to discover the views of interviewees on the main reasons for/ benefits of implementation of Six Sigma programme in the Middle East organisations, based on their own experience.

7.3.1.1 Tabular data presentation

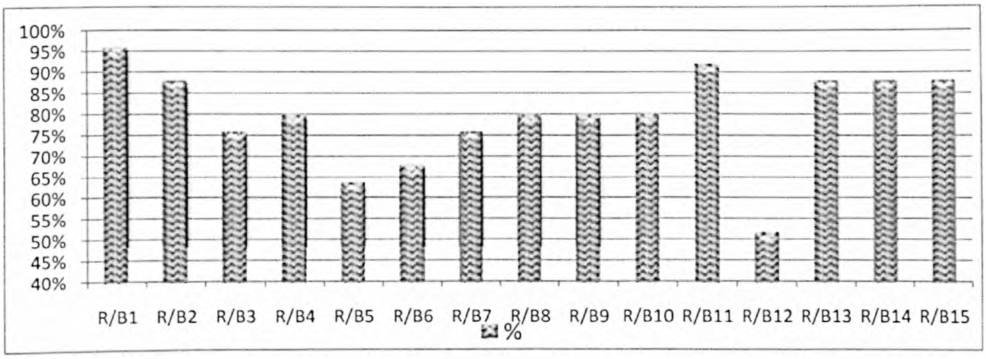
Table 7.23 summarises the most significant reasons/benefits, denoted by R/B, given by interviewees and their percentage and ranking in the Middle East. Figure 7.23 presents the results graphically in the form of bar charts.

The table and figure show the overall results of the analysis of the interview data in which the percentages for all 15 reasons for/ benefits of Six Sigma implementation were quite high. In addition, the most significant reason for/ benefit of the Six Sigma implementation in the Middle East was 'improving customer satisfaction (understanding customer needs and expectations)' followed by 'improving business, financial performance and organisation efficiency'. The third reason/benefit was 'improving process performance continuously from reactive to proactive'. 'Building organisation reputation and creating new customer opportunities' was the fourth and the fifth reason/benefit in ranking was 'improving and increasing earnings, profitability and market share'.

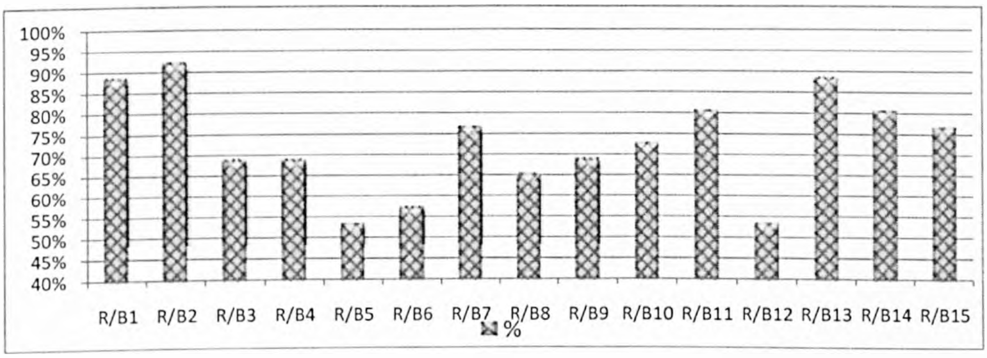
Table 7.23: Percentages and ranking of reasons for/ benefits of Six Sigma implementation in Middle East organisations

No.	Reasons for/ benefits of Six Sigma implementation	Saudi Arabia		Egypt		UAE		Overall		
		No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**	**Ranking**
R/B1	Improving customer satisfaction (understanding customer needs and expectations)	24	96.00	23	88.46	23	100.00	**70**	**94.59**	**1**
R/B2	Improving business, financial performance and organisation efficiency	22	88.00	24	92.31	22	95.65	**68**	**91.89**	**2**
R/B3	Reducing defect /error rate, waste chain reduction and process cycle times	19	76.00	18	69.23	21	91.30	**58**	**78.38**	**9**
R/B4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	20	80.00	18	69.23	16	69.56	**54**	**72.97**	**11**
R/B5	Gaining competitive advantage	16	64.00	14	53.84	17	73.91	**47**	**63.51**	**14**
R/B6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	17	68.00	15	57.69	16	69.56	**48**	**64.86**	**13**
R/B7	Changing and improving organisation culture	19	76.00	20	76.92	22	95.65	**61**	**82.43**	**7***
R/B8	Achieving faster and on-time delivery	20	80.00	17	65.38	14	60.87	**51**	**68.92**	**12**
R/B9	Decreasing employee workloads for undesirable work	20	80.00	18	69.23	17	73.91	**55**	**74.32**	**10**
R/B10	Improving employees effectiveness, efficiencies and satisfaction in their performance	20	80.00	19	73.01	22	95.65	**61**	**82.43**	**7***
R/B11	Reducing capital spending (operational costs, overhead production costs)	23	92.00	21	80.77	18	78.26	**62**	**83.78**	**6**
R/B12	Using resources effectively	13	52.00	14	53.84	17	73.91	**44**	**59.46**	**15**
R/B13	Building organisation reputation and creating new customer opportunities	22	88.00	23	88.46	20	86.96	**65**	**87.84**	**4**
R/B14	Improving process performance continuously from reactive to proactive	22	88.00	21	80.77	23	100.00	**66**	**89.19**	**3**
R/B15	Improving and increasing earnings, profitability and market share	22	88.00	20	76.92	21	91.30	**63**	**85.35**	**5**
Total		25		26		23		74		

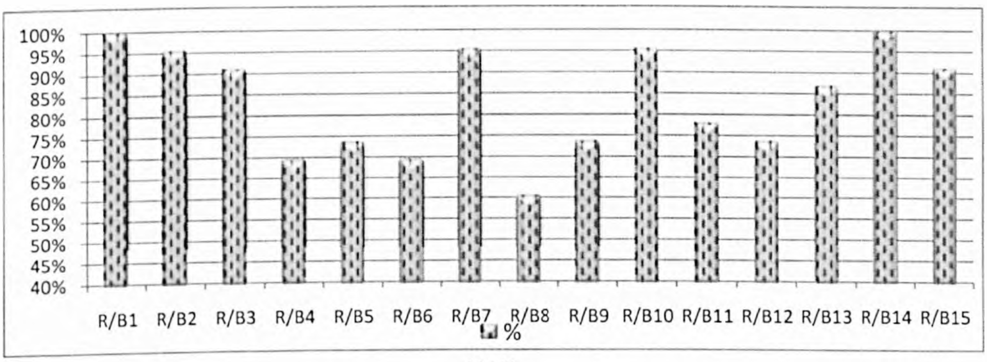
* Another item(s) with same rank (tied rank)



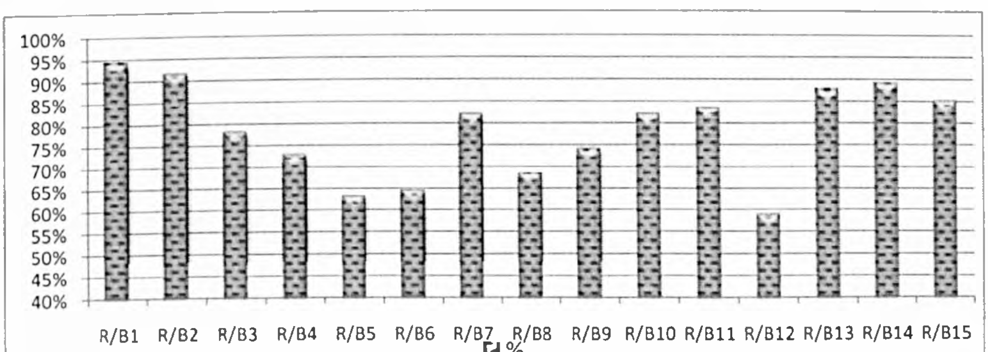
Saudi Arabia



Egypt



UAE



Overall

Figure 7.23: Overall percentages of reasons for/ benefits of Six Sigma implementation in Middle East organisations

7.3.1.2 Interviewees' quotations

The following is a description of the leading 15 reasons for/ benefits of Six Sigma implementation in the Middle East organisations and quotations from interviewees, sorted by their ranking (descending) (Table 7.23), (see Appendix F).

1. ***R/B1 - Improving customer satisfaction (understanding customer needs and expectations)*** was the most significant reason for/ benefit of implementing Six Sigma in the Middle East organisations. Its score was impressively high (70 interviewees out of 74, 94.59%). One of the interviewees explained:

> "*Many Middle East organisations have had recurring problems associated with products and services to customers which did not meet customer specifications and therefore caused the customer to be unhappy. By significantly lowering defect rates, the organisation will be able to produce products to customers consistently which strictly meet the customer specifications and therefore increase customer satisfaction.*" *(Mr. 2, Organisation S-B, Black Belt).*

Another interviewee said:

> "*It is important to meet our customers' satisfaction, their expectations are on top of our goals.*" *(Mr. 1, Organisation U-D, Master Black Belt).*

One more interviewee stated:

> "*Understanding customers is the key to give them a good product or service. Organisations have to expect customers' needs and exceed their expectations.*" *(Mr. 3, Organisation E-B, Green Belt).*

2. The second most significant reason for/ benefit of implementing Six Sigma in the Middle East organisations was ***R/B2 - improving business, financial performance and organisation efficiency*** (68 interviewees out of 74, 91.89%, again impressive). One interviewee stated that:

> "*For my organisation, improving business, organisation efficiency and financial performance are one of the main reasons and benefits of implementing the Six Sigma programme.*" *(Mr. 1, Organisation E-C, Black Belt).*

And another interviewee:

> *"We gain an improvement and higher efficiency of process that lead to improve the performance and financial return." (Mr. 1, Organisation S-E, Senior Manager).*

3. ***R/B14 - Improving process performance continuously from reactive to proactive*** was in the third position (66 interviewees out of 74, 89.19%). One interviewee stated that:

> *"Improving process performance continuously from reactive to proactive is one of the main goals for organisations that looking to implement the continuous improvement that it consider one of benefits of Six Sigma implementation." (Mr.1, Organisation S-J, Black Belt).*

Another interviewee commented:

> *"If Six Sigma is implemented in the correct way, organisations will derive greater benefits and will be able to use Six Sigma to its maximum potential of improving process performance continuously from reactive to proactive." (Mr. 2, Organisation U-A, Champion).*

4. ***R/B13 - Building organisation reputation and creating new customer opportunities*** was in the fourth position (65 interviewees, 87.84%). One interviewee stated that:

> *"Good reputation will help the organisations develop strong relationships with customers, win funding and enhance influence." (Mr. 2, Organisation E-F, Master Black Belt).*

An input from another interviewee was:

> *"With good reputation in our organisation, new customers can believe in our potential." (Mr.2, Organisation U-K, Green Belt).*

5. The fifth most significant reason for/ benefit of implementing Six Sigma in the Middle East organisations was ***R/B15 - improving and increasing earnings, profitability and market share*** (63 interviewees, 85.35%). One interviewee stated that:

> *"Our organisations goals from implementing Six Sigma programme were profitability, improving earning and increasing market share." (Mr. 1, Organisation E-B, Quality Manager).*

Another interviewee said:

> "*Improving and increasing profitability, earnings and market share is one of the most significant reasons for/ benefits of implementing Six Sigma in my organisation and most, if not all, other organisations that are implementing Six Sigma." (Mr. 3, Organisation S-A, Black Belt).*

6. ***R/B11 - Reducing capital spending (operational costs, overhead production costs)*** was in the sixth position (62 interviewees, 83.78%). One interviewee stressed:

> "*I emphasise the importance of Six Sigma to my organisation in light of the current economic conditions. The organisation realised significant savings from Six Sigma initiative. Going forward, we will continue to focus on Six Sigma to drive operational excellence, improve our performance for customers, enabling increased market penetration, reduced working capital, and improved competitive cost position." (Mr. 1, Organisation S-B, CEO).*

Another interviewee's comment was:

> "*The main goal is to reduce capital spending which includes operational cost and overhead production costs." (Mr. 3, Organisation S-A, Black Belt).*

7. Concerning ***R/B7 - changing and improving organisation culture*** (placed equal 7th by 61 out of 74 interviewees, 82.43%), one interviewee stated:

> "*With Six Sigma, the organisation's culture shifts to one that includes a systematic approach to problem solving and a pro-active attitude among employees." (Mr. 1, Organisation E-K, Quality Manager).*

Another interviewee said:

> "*Successful Six Sigma programmes also contribute to the overall sense of pleasure of the organisation's employees." (Mr 2, Organisation, U-I, Master Black Belt).*

A third interviewee remarked:

> "*By changing and improving organisation culture can improve success of Six Sigma implementation." (Mr. 1, Organisation E-M, Black Belt).*

8. Also equal 7th (61 interviewees, 82.43%), regarding ***R/B10 - improving employees' effectiveness, efficiencies and satisfaction in their performance***, one interviewee said:

> "*Improving employees' effectiveness, efficiencies and satisfaction can influence our goal of organisation.*" *(Mr. 1, Organisation S-A, Quality Manager).*

For another interviewee:

> "*In my opinion, I think improving employees' satisfaction, effectiveness and efficiencies in their performance is the most significant reason for/ benefits of implementing Six Sigma in my organisation.*" *(Mr. 1, Organisation E-E, Black Belt).*

9. Regarding ***R/B3 – reducing defect/error rate, waste chain reduction and process cycle times***, in 9th place (58 interviewees out of 74, 78.39%), one interviewee observed:

> "*By lowering defect rates, our organisation eliminated wastage of materials and inefficient use of labour which is associated with defects.*" *(Mr. 2, Organisation E-H, Green Belt).*

And another interviewee commented:

> "*By implementing Six Sigma this can reduce defects ,error rate and cycle time.*" *(Mr. 1, Organisation E-C, Black Belt).*

10. Concerning ***R/B9 - decreasing employee work loads for undesirable work,*** (placed 10th by 55 out of 74 interviewees, 74.32%), one interviewee stated that:

> "*Implanting Six Sigma can reduce workloads, therefore improving employee performance.*" *(Mr. 1, Organisation S-L, Senior Manager).*

Another interviewee's view was:

> "*Decreasing employee work loads for undesirable work is one of the significant reasons for/ benefits of implementing Six Sigma in a Six Sigma organisation.*" *(Mr. 2, Organisation U-C, Black Belt).*

11. R/B4 - Planning strategically and positively (measuring pre-defined goals and defining full layout of processes) was in the 11th position (54 interviewees, 72.97%). One interviewee pointed out:

> *"Six Sigma can enhance planning strategy." (Mr. 1, Organisation S-O, Black Belt).*

Comments by another interviewee were:

> *"Organisations are increasingly realising that traditional forms of management based on the same approach to every project cannot meet the needs of today' economic, social, and business environment. Additionally, the processes can be streamlined based on technologies and efficiencies not previously available." (Mr. 2, Organisation E-K, Senior Manager).*

12. R/B8 - Achieving faster and on-time delivery was cited by 51 interviewees, (68.92%) at 12th position. One interviewee stated that:

> *"Achieving faster and on-time delivery is very important, because a common problem for many organisations is a high rate of delayed deliveries to customers. The variations which can be eliminated in a Six Sigma project can include variations in delivery time. Therefore Six Sigma can be used to help ensure consistent on-time-delivery." (Mr. 2, Organisation S-L, Master Black Belt).*

Another interviewee also recognised this:

> *"Six Sigma can eliminate variation in delivery time, so it can be used to ensure on-time delivery." (Mr. 1, Organisation U-G, General Manager).*

13. R/B6 - Empowering, encouraging and improving the decision-making role (improved communications, education, knowledge, creativeness and cross-functional teamwork), 48 interviewees (64.86%) placed it 13th. One interviewee stated that:

> *"By implementing Six Sigma this improve empowering and decision making role in different ways." (Mr. 2, Organisation E-H, Green Belt).*

For another:

> *"Improving the decision-making role is one of implementing Six Sigma for some organisations." (Mr. 1, Organisation U-E, Black Belt).*

And a third one said:

> "*Improving communications, education, knowledge, creativeness and functional teamwork was the ultimate reason for implementing Six Sigma initiative for my organisation." (Mr. 1, Organisation S-R, Champion).*

14. R/B5 **-** Concerning ***gaining competitive advantage*** was placed last (14^{th}) by 47 out of 74 interviewees (63.51%), one interviewee said:

> "*Understanding customers can help any organisation to see the changes that need to be made in order to maintain or gain competitive advantage." (Mr. 3, Organisation E-N, Black Belt).*

Another interviewee saw this benefit:

> "*Six Sigma helps in gaining competitive advantage." (Mr. 2, Organisation U-C, Black Belt).*

15. R/B12 - Using resources effectively was placed last (15^{th}) but not least, by 44 out of 74 interviewees (59.46%). One interviewee said:

> "*Six Sigma helps in applying resources effectively." (Mr. 1, Organisation U-H, Black Belt).*

Another interviewee emphasised the point:

> "*Effective use of organisation resources is critical to our profitability." (Mr. 1, Organisation S-O, Black Belt).*

A third interviewee's comment was that:

> "*Six Sigma programme play a key role in allocating resources throughout a business so that the Six Sigma projects set in." (Mr. 4, Organisation S-A, Green Belt).*

In this final quotation, another interviewee said:

> "*One of the ultimate reasons for implementing Six Sigma initiative for my organisation was using resources effectively (time, money and human)." (Mr. 1, Organisation S-R, Champion).*

7.3.2 Challenges in Six Sigma Implementation (Interview, Section 6)

Next, the interviewees were asked about the main challenges in implementation of the Six Sigma programme in the Middle East organisations, based on their experience of implementation in their own organisations. According to their responses, there appear to be 13 main challenges encountered by organisations attempting to implement Six Sigma in the Middle East.

7.3.2.1 Tabular data presentation

Table 7.24 summarises the main significant challenges in Six Sigma implementation in Middle East organisations as perceived by interviewees and their percentage and ranking, which obstruct them in implementing Six Sigma projects. Figure 6.24 presents the results graphically in the form of bar charts.

The table and figure show the overall results of the analysis of the interview data in which the percentages for all 13 significant challenges in Six Sigma implementation were quite high. In addition, overall, the most significant challenge was 'lack of top management commitment and support'. The second was 'organisational resistance (fear of change)'. The third highest ranking challenge in Six Sigma implementation was 'lack of communication'. The fourth most significant was 'lack of measurement of customer satisfaction', while equal fifth were 'lack of resources' and 'insufficient training'.

Table 7.24: Percentages and ranking of challenges of Six Sigma implementation in Middle East organisations

No.	Challenges of Six Sigma implementation	Saudi Arabia		Egypt		UAE		**Overall**		
		No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**	**Ranking**
C1	Lack of top management commitment and support	25	100.00	25	96.15	23	100.00	**73**	**98.65**	**1**
C2	Lack of communication	24	96.00	25	96.15	22	95.65	**70**	**94.59**	**3**
C3	Organisational resistance (fear of change)	24	96.00	24	92.31	23	100.00	**71**	**95.95**	**2**
C4	Lack of teamworking	16	64.00	14	53.85	16	69.56	**46**	**62.16**	**13**
C5	Lack of resources	23	92.00	21	80.77	21	91.31	**65**	**87.84**	**5***
C6	Cost of training and consulting and long time needed for training	17	68.00	19	73.08	13	56.52	**49**	**66.22**	**12**
C7	Selecting suitable projects	20	80.00	23	88.46	19	82.61	**62**	**83.78**	**7**
C8	Lack of measurement of customer satisfaction	22	88.00	24	92.31	22	95.65	**68**	**91.89**	**4**
C9	Lack of reward system	22	88.00	18	69.23	21	91.31	**61**	**82.43**	**8**
C10	Lack of data availability, collection and analysis	21	84.00	23	88.46	15	65.22	**59**	**79.73**	**9**
C11	Insufficient training	23	92.00	21	80.77	21	91.31	**65**	**87.84**	**5***
C12	Poor project management	21	84.00	15	57.69	16	69.56	**52**	**70.27**	**11**
C13	Lack of implementing statistical tools and techniques	20	80.00	17	65.38	19	82.61	**56**	**75.67**	**10**
Total		25		26		23		74		

* Another item(s) with same rank (tied rank)

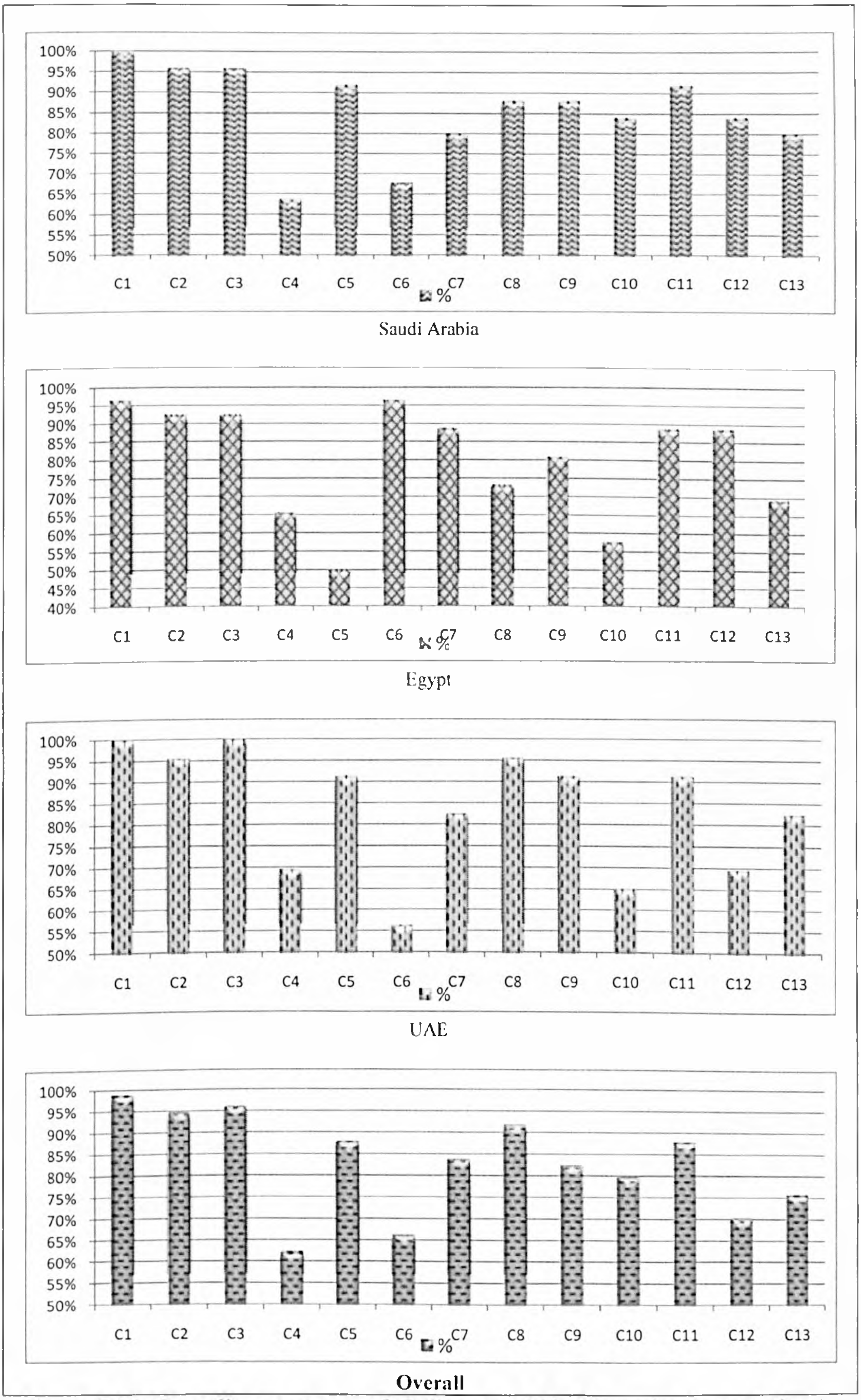


Figure 7.24: Overall percentages of challenges of Six Sigma implementation in Middle East organisations

7.3.2.2 Interviewees' quotations

The following is a description of the 13 major challenges in Six Sigma implementation in the Middle East organisations and quotations from interviewees, sorted by their ranking (descending) (Table 7.24), (see Appendix F).

1. C1 - Lack of top management commitment and support

The major challenge in Six Sigma implementation in Middle East organisations was the lack of top management commitment and support, chosen by 73 interviewees out of 74 (98.65%). One interviewee commented:

> *"There was a distinct lack of evidence of management commitment to the Six Sigma implementation." (Mr. 1, Organisation E-F, General Manager).*

Another reported:

> *"There has recently been a change in top management personnel, and I need to work with the new director to try and re-create the previous high levels of communication regarding quality. We have planned a number of presentations, team talks, and management walk about." (Mr. 1, Organisation U-K, Master Black Belt).*

2. C3 - Organisational resistance (fear of change)

The second major challenge was organisational resistance (fear of change), chosen by 71 interviewees (95.95%). Some of the interviewees described the organisational resistance challenge in different ways as follows:

- *"Employees' resistance is a big challenge in our organisation, because most of our employees do not like changes in job style. They may not contribute in such a project; the reason in my opinion is the lack of rotation and lack of team work involvement." (Mr. 1, Organisation E-D, Champion).*

- *"Most people don't like change because they don't like being changed. When change comes into view, fear and resistance to change follow - often despite its obvious benefits." (Mr. 2, Organisation U-C, Black Belt).*

- *"People fight against change because they fear to lose something they value, or don't understand the change and its implications, or don't think that the change makes sense, or find it difficult to cope with either the level or pace of the change." (Mr. 1, Organisation S-K, Black Belt).*

- *"It was slightly hard to change employee culture because most of them found it's difficult to accept any changes; we faced some difficulties at the beginning." (Mr. 1, Organisation S-M, CEO).*

- *"Some employees work in one place for a long time and the job process becomes part of their daily routine, so they cannot easily accept the change." (Mr. 3, Organisation E-N, Black Belt).*

- *"The concept of Six Sigma is very new in the Middle East and because of the short and long-term focus in business, it is difficult for organisations to get the changes to their culture."* (Mr.1, Organisation S-J, Black Belt).

- *"At the beginning, all people within out organisation, employees, managers, were aware of the organisational culture change." (Mr. 1, Organisation E-G, Green Belt).*

- *"I think most of the resistance has come from employees. Perhaps they are not always sufficiently involved in the strategic planning and don't always buy in to Six Sigma as a means of achieving business goals, yet they are the ones who really have to deliver Six Sigma throughout the organisation - they play a crucial role." (Mr. 1, Organisation E-A, CEO).*

- *"The biggest challenge is winning over the hearts and minds of staff when bringing in organisational change." (Mr. 2, Organisation U-F, Quality Manager).*

3. C2 - Lack of communication

Another challenge was the lack of communication, cited by 70 interviewees (94.59%). One interviewee saw that:

> *"Lack of understanding of Six Sigma principles, techniques and tools leads to lack of effective communication of the Six Sigma message deployments. This, in turn, leads to lack of commitment to Six Sigma implementation." (Mr. 1, Organisation S-C, Champion).*

Another interviewee observed:

> *"For some organisations, it is more difficult to establish good relationships between all levels and that can hinder their progress in Six Sigma." (Mr. 1, Organisation E-I, Quality Manager).*

A third interviewee said:

> *"I think that lack of communication is one of the most significant challenges for the successful implementation of Six Sigma in this organisation." (Mr. 2, Organisation U-J, Black Belt).*

4. C8 - Lack of measurement of customer satisfaction

The next major challenge is lack of measurement of customer satisfaction, which was cited by 68 interviewees (98.65%) as one of the major challenges to Six Sigma implementation in Middle East organisations. One of the interviewees pointed to the challenge of lack of measurement of customer satisfaction as follows:

> *"Lack of measurement of customer satisfaction is one of the major challenges. Without measurement of customer satisfaction, an organisation cannot possibly know which processes are working efficiently and effectively, what products and services are meeting customer expectation and needs, and whether or not customer requirements are being satisfied." (Mr. 2, Organisation U-I, Master Black Belt).*

Another interviewee stated:

> *"It is no secret that organisations want to hold on to their customers. After all, repeat customers are a key part of success in the business world. The general belief is that it costs organisations much more money to get new clients than it does to simply keep existing customers. This is why measuring customer satisfaction is so vitally important." (Mr. 1, Organisation U-B, CEO).*

5. C5 - Lack of resources

According to the interviewees, another challenge frequently faced when implementing Six Sigma in the Middle East is the lack of resources. It was cited by 65 interviewees (87.84%) as the fifth of the major challenges. One interviewee stated:

> *"Implementing a new practice is always a challenge, especially when there is a need to train people first. It represents a short-term cost to business, and top management are not always able to see the longer-term benefits of this." (Mr. 1, Organisation S-H, Master Black Belt).*

Another interviewee commented:

"Lack of resources can affect Six Sigma negatively." (Mr. 2, Organisation S-C, Green Belt).

6. C11 - Insufficient training

Another challenge to Six Sigma implementation in the Middle East was insufficient training as cited by 65 interviewees (87.84%). Training for all levels of an organisation is of fundamental importance and must be provided continuously, as mentioned by some of the Middle East quality experts interviewed as follows:

- *"Employees must be well trained to a certain level of confidences so they can perform the new tasks and behave in the way expected of them in solving their daily problems. Efforts to force change without preparing the ground and giving the right support and training for the individual will not get the organisation any further in its quality movement." (Mr. 1, Organisation U-E, Black Belt).*

- *"Staying competitive is the key to sustainability. Training employees, keeping them motivated and up-to-date with industry trends and new technologies, is essential to achieving that goal." (Mr. 1, Organisation E-C, Black Belt).*

- *"Employees benefit too, learning new skills and becoming a valued asset in any organisation. Training brings direct benefits to the business and can be calculated as a return on investment." (Mr. 1, Organisation E-J, General Manager).*

- *"The organisation develops various training courses for its departments, but sometimes these courses are not appropriate to the trainee's level and abilities, or sometimes the subject is not related to the job description that the trainee will be appointed for." (Mr. 1, Organisation U-J, Champion).*

- *"Ensuring that the employees have the right skills is crucial to the growth and success of the business." (Mr. 2, Organisation S-G, Green Belt).*

Another interviewee referred to research findings on training benefits:

"Researches show that training can increase productivity and quality of work, increase profits, reduce staff turnover and absenteeism, improve customer satisfaction, and improve motivation." (Mr. 1, Organisation S-K, Black Belt).

7. C13 - Selecting suitable projects

The selecting of suitable projects was also cited by 62 interviewees (83.78%) as the 7th of the challenges in Six Sigma implementation in the Middle East. One interviewee stated:

> *"The selection of the most suitable project is a key factor contributing to overall customer satisfaction and project success." (Mr. 3, Organisation S-A, Black Belt).*

Another interviewee said:

> *"The selection of the most suitable project is critical for both customers and project participants, and is becoming an important and contemporary issue within the building industry." (Mr. 2, Organisation U-I, Master Black Belt).*

8. C9 - Lack of reward system

The next challenge is lack of a reward system, cited by 61 interviewees (82.43%) as the 8th major challenge in Six Sigma implementation in Middle East organisations. Some interviewees showed that:

- *"The only way employees will fulfil your dream is to share in the dream. Reward systems are the mechanisms that make this happen." (Mr. 3, Organisation E-N, Black Belt).*

- *"With a good reward system, they could easily overcome this kind of challenge." (Mr. 1, Organisation E-G, Green Belt).*

- *"Our organisation rewards and recognises employees, and directly connects the reward with the behaviour and higher performance they've attained." (Mr. 1, Organisation S-E, Senior Manager).*

A fourth interviewee went straight to the point:

> *"Failing to reward the right behaviour, most likely gets the wrong results." (Mr. 3, Organisation U-A, Black Belt).*

9. C10 - Lack of data availability, collection and analysis

59 interviewees out the 74 (79.73%) cited the lack of data availability, collection and analysis as the 9th of the challenges of Six Sigma implementation in the Middle East. One interviewee stated:

> *"Lack of data availability is considered one of main challenges that can result in inability for analysis." (Mr. 1, Organisation U-C, Black Belt).*

Another interviewee said:

> *"Difficulty in collection and available data can make analysis difficult in any organisation." (Mr. 2, Organisation S-L, Master Black Belt).*

10. C13 - Lack of implementing statistical tools and techniques

Another challenge has been the lack of implementing statistical tools and techniques. It was cited by 56 interviewees (75.67%) as the 10th of the challenges in Six Sigma implementation in the Middle East. Some interviewees reflected that:

- *"We have training classes that provide us with all statistical data needed to create our Six Sigma projects." (Mr. 2, Organisation S-B, Black Belt).*

- *"Successful implementation needs understanding not only in statistics but also in using them to gain better results. We have experts working in the area and they can help us in such a project, so it is not an obstacle to implementing the Six Sigma project in our division." (Mr. 2, Organisation E-N, Champion).*

- *"Literature increasingly shows that implementing statistical tools and techniques is essential to achieve Six Sigma projects. Successful Six Sigma implementation requires successful use of statistical tools and techniques." (Mr. 1, Organisation U-K, Green Belt).*

A final contribution was:

- *"It is not just the Black Belts who combine project roles with the development of the culture change that takes place when Six Sigma is deployed. The entire organisation is impacted on by the culture change, and there are lessons to learn." (Mr. 3, Organisation U-A, Black Belt).*

11. C12 - Poor project management

Poor project management was also cited by 52 interviewees (70.27%) as the 11th challenge of Six Sigma implementation in the Middle East. One interviewee stated:

> "*Poor project management can lead to failure in an organisation.*" *(Mr. 1, Organisation E-E, Black Belt).*

Another interviewee said:

> "*In my opinion, in this organisation, the poor project management was one of the most significant challenges for the successful implementation of Six Sigma.*" *(Mr. 1, Organisation S-N, General Manager).*

12. C6 - Cost of training and consulting and long time needed for training

Another challenge (12th) to Six Sigma implementation was cost of training and consulting and the long time needed for training cited by 49 interviewees (66.16%). One interviewee stated:

> "*Some major defect is cost of training and consultation with a long time scale which can be considered a big challenge.*" *(Mr. 1, Organisation S-A, Quality Manager).*

Another comment was:

> "*Organisation top management sometimes think the Six Sigma process is more complicated than it really is.*" *(Mr. 2, Organisation E-A, Black Belt).*

13. C4 - Lack of teamworking

The last major challenge to Six Sigma in Middle East organisations was the lack of teamworking, 46 interviewees out of 74 (62.16%) chose it as the last (13th) major challenge to Six Sigma implementation in Middle East organisations. Some interviewees stated:

- "*There is a saying that many hands make light work. The essence of this statement is that more can be achieved as a collective than individually. There are numerous benefits of teamwork.*" *(Mr. 2, Organisation U-K, Quality Manager).*

- *"We all have different skills, knowledge and personal attributes. By utilising all of these different aspects in a team, more ideas can be generated. As more ideas are generated, more creative solutions are generated, leading to better results." (Mr. 1, Organisation S-G, Black Belt).*

- *"Even the best certified/qualified individual cannot have all of the skills to do everything. Some people excel at coming up with the ideas. Others love the detail, while there are those that focus on the big picture. There are others who can be counted on when it comes to implementing and following through of a plan." (Mr.2, Organisation E-F, Master Black belt).*

A final interviewee commented:

- *"The key point is that when a team works together, it has a huge range of skills available that it can utilise to deliver extraordinary results." (Mr. 1, Organisation U-E, Black Belt).*

Finally, one of the related challenges highlighted by the interviewees is where Six Sigma is a new concept for the Middle East organisations as:

- *"In general, the concept of Six Sigma is a totally new concept in the Middle East." (Mr.1, Organisation S-J, Black Belt).*

7.3.3 Critical Success Factors for Six Sigma Implementation (Interview, Section 7)

The aim of the question of this section was to obtain the view of interviewees on the main CSFs of implementation of the Six Sigma programme in the Middle East organisations. They were asked to address the more significant CSFs based on their experience of implementation in their organisations.

7.3.3.1 Tabular data presentation

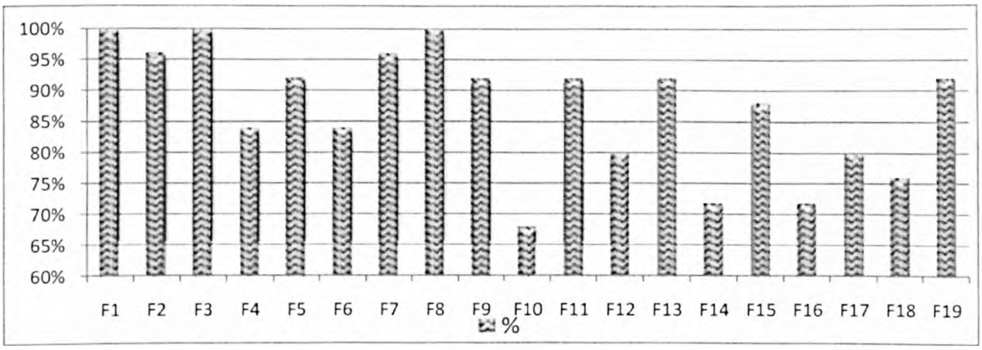
Table 7.25 summarises the results for the more significant CSFs that led to implementing Six Sigma projects successfully in the Middle East given by interviewees with their percentages and ranking, while Figure 6.25 presents the results graphically in bar charts.

The overall results of the analysis of the interview data show percentages for all 19 significant CSFs of Six Sigma implementation were quite high. In addition, overall, the most significant CSF was 'top management commitment and support', second equal were 'readiness for cultural change' and 'continuous training and education', third was 'integrating Six Sigma with customer satisfaction'. The fourth was 'integrating Six Sigma with corporate business strategy'. The equal fifth most significant CSFs were, 'formation of Six Sigma organisational structure' and 'project management skills'.

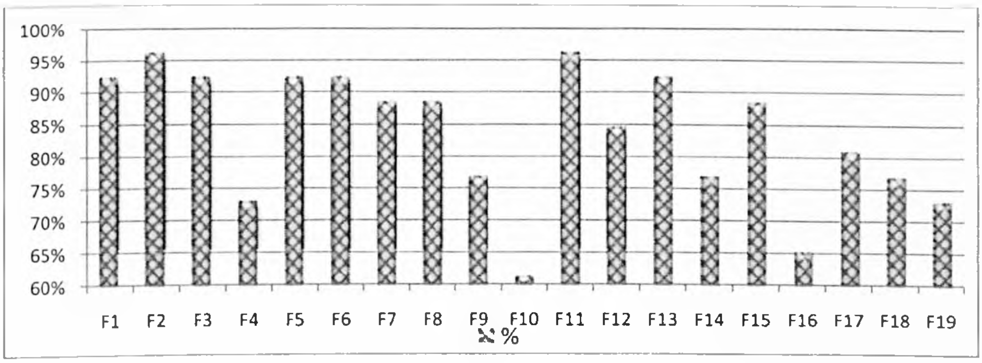
Table 7.25: Percentages and ranking of CSFs of Six Sigma implementation in Middle East organisations

No.	CSFs of Six Sigma implementation	Saudi Arabia		Egypt		UAE		**Overall**		
		No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**	**Ranking**
F1	Top management commitment and support	25	100.00	24	92.31	23	100.00	**72**	**97.30**	**1**
F2	Readiness for cultural change	24	96.00	25	96.15	22	95.65	**71**	**95.95**	**2***
F3	Continuous training and education	25	100.00	24	92.31	22	95.65	**71**	**95.95**	**2***
F4	Teamwork	21	84.00	19	73.08	22	95.65	**62**	**83.78**	**13**
F5	Effective communication	23	92.00	24	92.31	19	82.61	**66**	**89.19**	**9***
F6	Formation of Six Sigma organisational structure	21	84.00	24	92.31	23	100.00	**68**	**91.89**	**6***
F7	Integrating Six Sigma with customer satisfaction	24	96.00	23	88.46	22	95.65	**69**	**93.24**	**5**
F8	Integrating Six Sigma with corporate business strategy	25	100.00	23	88.46	22	95.65	**70**	**94.59**	**4**
F9	Integrating Six Sigma with employees	23	92.00	20	76.92	22	95.65	**65**	**87.84**	**11**
F10	Integrating Six Sigma with suppliers	17	68.00	16	61.54	20	86.96	**53**	**71.62**	**19**
F11	Integrating Six Sigma with financial goals	23	92.00	25	96.15	18	78.26	**66**	**89.19**	**9***
F12	Integrating Six Sigma with existing initiatives	20	80.00	22	84.61	19	82.61	**61**	**82.43**	**14***
F13	Integrating Six Sigma with rewards and recognition system	23	92.00	24	92.31	20	86.96	**67**	**90.54**	**8**
F14	Use of Six Sigma methodologies and tools	18	72.00	20	76.92	21	91.30	**59**	**79.73**	**16**
F15	Project management skills	22	88.00	23	88.46	23	100.00	**68**	**91.89**	**6***
F16	Project prioritisation, selection, evaluation, tracking and reviews	18	72.00	17	65.38	19	82.61	**54**	**72.97**	**18**
F17	Integrating Six Sigma with information technology (IT) infrastructure	20	80.00	21	80.77	20	86.96	**61**	**82.43**	**14***
F18	Competitive benchmarking for Six Sigma	19	76.00	20	76.92	17	73.91	**56**	**75.67**	**17**
F19	Use of external consultants	23	92.00	19	73.08	22	95.65	**64**	**86.49**	**12**
Total		25		26		23		74		

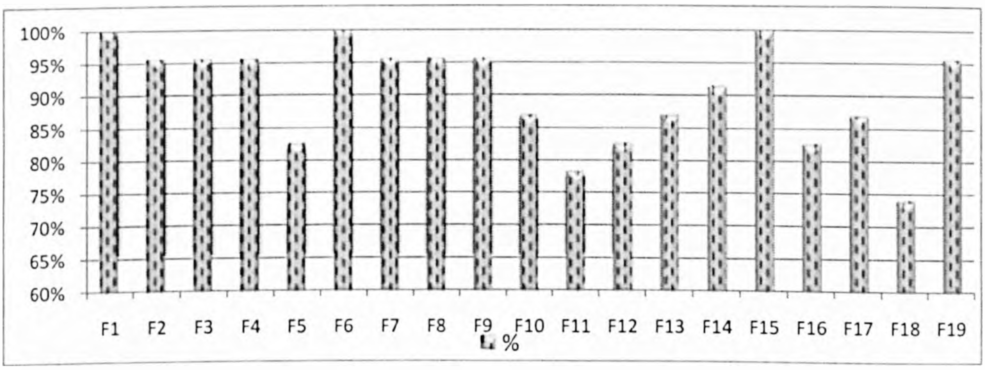
* Another item(s) with same rank (tied rank)



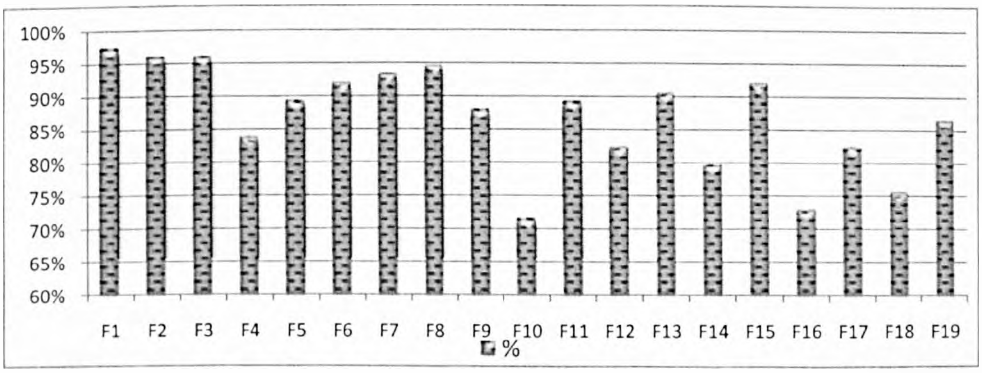
Saudi Arabia



Egypt



UAE



Overall

Figure 7.25: Overall percentages of CSFs of Six Sigma implementation in Middle East organisations

7.3.3.2 Interviewees' quotations

The following is a description of the 19 CSFs of Six Sigma implementation in the Middle East organisations and quotations from interviewees, sorted with ranking (descending order) (Table 7.25), (see Appendix F).

1. F1 - Top management commitment and support

The most significant CSF in Six Sigma implementation in Middle East organisations was the top management commitment and support, 72 interviewees out of 74 (97.30%) choosing it as the most important for Six Sigma implementation in that context. Some of the interviewees described its importance as follows:

- *"To introduce Six Sigma to an organisation and make it successful, the senior top management would require to be fully knowledgeable, committed and supporting, to understand the reason for choosing a certain approach and be quite keen to see the results through the performance criteria they use." (Mr. 1, Organisation U-B, CEO).*

- *"For Six Sigma to be successful, the top management is committed in leading its employees. A top management must understand Six Sigma, believe in it and then demonstrate their belief and commitment through their daily practice of it." (Mr. 2, Organisation U-I, Master Black Belt).*

- *"All top management, middle managers and employees have agreed to major changes in their organisations' journeys, as well as their organisation's share of the benefits, on the first commitment day. These changes have still to be communicated to and agreed with the middle managers and employees working in the areas where the changes take place." (Mr. 2, Organisation S-L, Master Black Belt).*

- *"They cannot be expected to agree and commit to targets for benefits without being involved in a more detailed design of the changes processes and in discussions on how far they can 'stretch' in meeting new targets for improvement." (Mr. 1, Organisation E-F, General Manager).*

- *"Our top management participates in Six Sigma management and improvement process. Six Sigma issues always represent a very hot subject in top management meetings." (Mr. 2, Organisation U-J, Black Belt).*

- *"The move from a traditional management philosophy to a Six Sigma culture demands much from an organisation, it is not easy, it needs a very strong commitment from the top management, so it is non-stop effort." (Mr. 1, Organisation S-I, Green Belt).*

- *"No success of Six Sigma would have been possible without top management commitment and our top management were following the activity of the Six Sigma programme day by day until Six Sigma became a daily routine in the organisation. Our top management made a good effort to reach where we are now." (Mr. 1, Organisation U-D, Master Black Belt).*

- *"Because of the strong commitment of the management, we did not face many problems. Only introducing was not very easy, and determining the core processes for every stages. Now we do not panic about these processes and they are taking them as a routine job and a good chance for improvement." (Mr. 1, Organisation E-M, Black Belt).*

- *"Top management at this organisation recognise the importance of having a new concept such as Six Sigma. Support will be helpful, such as making Six Sigma structure critical to the organisation's success, and providing funding and other resources or Six Sigma infrastructure are most important to the organisation." (Mr. 1, Organisation U-J, Champion).*

- *"Six Sigma in this organisation is almost recent, it needs more support by appointing some people with expertise to develop it, because the top management is open minded and accepts the suggestions." (Mr. 1, Organisation U-A, General Manager).*

- *"Top management should participate in all Six Sigma activities. They have to communicate to all levels. They have always had their own agenda which is always relevant to Six Sigma daily activities." (Mr. 1, Organisation U-C, Black Belt).*

- *"I believe that the cause of Middle East organisations' good performance is the success of managements to realise that there is a different way to manage their organisation - a way that yields better quality, higher productivity, more jobs and ability to survive the competition." (Mr. 2, Organisation E-F, Master Black Belt).*

- *"There is interest for learning and development, especially between top management who lead by good example." (Mr. 2, Organisation E-J, Green Belt).*

Another interviewee summed up the role of top senior management as:

- *"The Six Sigma programme cannot be implemented successfully without dedicated top senior management involvement, visible and vocal support, top management committed to Six Sigma help sustain interest over the long term, reinforce a continuous focus on process improvement and ensure quality goals are met." (Mr. 3, Organisation S-A, Black Belt).*

2. F2 - Readiness for cultural change

Another significant CSF is the ability of an organisation to create an effective culture of change. 71 interviewees out of 74 (95.95%) agreed that the change culture is essential to prepare an organisation to achieve successful Six Sigma implementation and an effective change culture will ensure a smooth implementation of Six Sigma with minimum resistance. Determining cultural readiness, whether an organisation is ready or not to embark on a Six Sigma initiative, is important. The importance of changing the culture of the organisation was indeed recognised as one of the most important CSFs in the Middle East organisations. The interviewees believed that Six Sigma cannot be successfully implemented without culture change. So, some interviewees commented as follows:

- *"The timing and readiness of the organisation to implement Six Sigma are very significant for successful and effective Six Sigma implementation in any organisation." (Mr. 1, Organisation S-O, Black Belt).*

- *"Changing the culture of the organisation was one of the most important CSFs in our organisation." (Mr. 4, Organisation S-A, Green Belt).*

- *"Changing the culture, in some organisations, some employees respond to these changes readily. In others, the need for change meets ongoing resistance, sometimes to the point of failure." (Mr. 1, Organisation S-E, Senior Manager).*

- *"Creating Six Sigma quality culture was the main potential challenge during the early stages of implementation. But with the management consistency and support we created a healthy environment for whole organisation involvement." (Mr. 1, Organisation U-D, Master Black Belt).*

- *"I do not think that Six Sigma can be successfully implemented without culture change." (Mr. 2, Organisation E-H, Green Belt).*

- "*Establishing a Six Sigma culture helps organisations earn customer satisfaction and loyalty.*" *(Mr. 2, Organisation E-D, Black Belt).*

- "*The Six Sigma team are agents of change who should spread the Six Sigma philosophy throughout the organisation.*" *(Mr. 1, Organisation E-D, Champion).*

- "*The most important factors for the success of Six Sigma are the top management commitment and the culture change. Moreover, it must be highlighted that creation of a Six Sigma culture is neither fast nor easy.*" *(Mr. 1, Organisation S-K, Black Belt).*

- "*Whether change comes easily or proves difficult to achieve depends in part on the atmosphere - the organisational culture leadership creates.*" *(Mr. 3, Organisation E-N, Black Belt).*

- "*Creation of a Six Sigma culture takes a long time; some organisations may take years to achieve a Six Sigma cultural transformation, but this time depends on the degree of current inefficiency and ineffectiveness in the organisation and the degree of commitment of management and employees alike.*" *(Mr. 1, Organisation S-C, Champion).*

- "*Our organisation which wishes to form the Six Sigma structure and culture of its employees has to improve a culture that encourages teamwork and effective communication.*" *(Mr. 2, Organisation U-C, Black Belt).*

- "*In the Middle East culture, it is difficult to achieve full success in communication, because there are many tribal origins with different mentalities.*" *(Mr. 1, Organisation E-G, Green Belt).*

- "*We faced the culture change; it is a very important factor for Six Sigma to succeed and it is also very difficult.*" *(Mr. 1, Organisation E-N, General Manager).*

- "*It has been clear to me that Six Sigma culture change provided a very good foundation for successful implementation of Six Sigma in my organisation.*" *(Mr. 2, Organisation E-D, Black Belt).*

- "*We spend a long time building up good Six Sigma culture based on the effective communication and involvement with our employees.*" *(Mr. 1, Organisation S-A, Quality Manager).*

Most of the interviewees identified that the best way to tackle resistance to change is through increased and sustained communication, motivation and education, as one interviewee stated:

- *"The Six Sigma change culture should cover many aspects, like communication, user involvement and formal training and education of all users at all levels." (Mr. 1, Organisation U-G, General Manager).*

3. F3 - Continuous training and education

Continuous training and education is one of the significant CSFs for Six Sigma implementation in the Middle East, as cited by 71 interviewees (95.95%) as the third place. Top management support for the training of all participants in Six Sigma was the most critical preliminary factor for consideration. As some of the Middle East interviewees stated:

- *"According to our organisation policy all employees and managers should enable and provide training." (Mr. 2, Organisation U-F, Quality Manager).*

- *"The organisation placed a high top on training and educating the Six Sigma team in principles of leadership, including modem management concepts such as empowering and involving employees rather than controlling, strategic planning from the perspective of the customer and dynamics of organisation change." (Mr. 1, Organisation E-A, CEO).*

- *"A good number of our employees were trained in the basics of the Six Sigma quality management programme, especially when we started introducing the programme in 2002, and now every employee receives specialised training to fulfil his task." (Mr. 1, Organisation S-E, Senior Manager).*

- *"I enjoy working for this organisation. It has a wealth of training and experience which provide excellent resources and learning opportunities forms." (Mr. 2, Organisation E-H, Green Belt).*

- *"The employees received a good training and they are skilled enough to do their jobs up to good standards and they are much disciplined. The problem is that they are not motivated, and we cannot do anything about it because of the strict old policies, which are imposed in all organisations by the government, and everybody knows about it, it is just a chronic disease." (Mr. 2, Organisation U-K, Quality Manager).*

- *"We have a clear system for identifying training needs and the training objectives usually are well defined, we measure the performance of the trainees after the training event." (Mr. 1, Organisation E-F, General Manager).*

- *"Having a good system of training is very important, and it should be made available to everyone in the organisation, regardless of level of seniority - this can be a challenge for some Middle East organisations. I think having trainers who understand the culture is very important, too." (Mr. 1, Organisation S-C, Champion).*

- *"The right employee training, development and education at the right time provides big payoffs for the employer in increased productivity, knowledge, loyalty and contribution. Learn the approaches that will guarantee a return on your investment in training." (Mr. 2, Organisation E-F, Master Black Belt).*

Finally, the interviewees emphasised the great importance of providing proper training for all members of the organisation, but also making the training sensitive to local cultures, as one interviewee said:

- *"Our organisation conducted sessions on Six Sigma quality initiative to inform and educate all level and to achieve a common understanding of the Six Sigma principle." (Mr. 1, Organisation U-A, General Manager).*

4. F8 - Integrating Six Sigma with corporate business strategy

The analysis of the study has shown that integrating Six Sigma with the corporate business strategy is the fourth CSFs for Six Sigma implementation in the Middle East, as cited by 70 interviewees (94.59%). This would be aligned with the definition of Six Sigma as a breakthrough improvement for business strategy (Harry and Schroeder, 2000). Therefore, success in implementing a Six Sigma project within an organisation relies on a successful business strategy. In essence, the Six Sigma must be closely aligned, integrated and linked to the overall business strategy and must produce a tangible result for the organisation as a whole.

One interviewee stated that:

> *"Six Sigma is part of our business culture, therefore we are trying to integrate it with corporate business strategy." (Mr. 1, Organisation S-B, CEO).*

Another interviewee said:

> *"Integrating Six Sigma with the corporate business strategy is a most critical factor for the successful implementation of Six Sigma." (Mr. 2, Organisation U-J, Black Belt).*

5. F7 - Integrating Six Sigma with customer satisfaction

Interviewees have identified integrating Six Sigma with customer satisfaction as the fifth most important driver behind the successful implementation of Six Sigma as cited by 69 interviewees (93.24%). Middle East organisations are making efforts to change their status and their customers have started to see improvement of product quality and services and often their expectations were reached. Satisfying customers can provide their loyalty to the organisation. Because of the high competition in the market, Middle East organisations have to pay much attention to their external and internal customers and this is reflected in the overall planning and execution of quality efforts. The organisations have demonstrated their commitment to the highest levels of customer satisfaction and this is clear in the following quotations from some of the interviewees:

- *"As we continue on our quality journey, we look forward to exceeding our customers' expectations by delivering the highest quality solutions at the lowest possible cost with Six Sigma programme." (Mr. 1, Organisation E-B, Quality Manager).*

- *"Middle East organisations have changed a lot, customer satisfaction represents a priority in our agenda; it is always mentioned in our management meetings." (Mr. 1, Organisation U-I, Champion).*

- *"In our organisation, customer information is available through normal routines. Customer satisfaction is seen as the organisation's highest priority. The organisation believes it will only be successful if customers are satisfied. Our organisation is sensitive to customer requirements and responds rapidly to them." (Mr. 1, Organisation S-H, Master Black Belt).*

- *"The Customer Survey feedback is discussed in the management review meeting and areas are identified for improvement Based on this is a further action plan and the responsibilities are fixed." (Mr. 2, Organisation U-K, Quality Manager).*

- *"We have established simple and effective complaints procedures so that problems can be resolved quickly and efficiently and to the customer's satisfaction. After every remedy and action, the customer is contacted to seek a positive feed back which should be documented." (Mr. 1, Organisation S-L, Senior Manager).*

- *"Satisfying a customer or knowing his requirement was an important issue in our organisation since now we have faced strong competition in quality and prices from abroad." (Mr. 1, Organisation U-J, Champion).*

- *"The primary reasons for assessing customer satisfaction are to maximise customer retention and to gain and build customer loyalty. Our management believes customer satisfaction surveys should be conducted a minimum of twice a year and a maximum of four times a year." (Mr. 1, Organisation S-M, CEO).*

- *"We need to influence our customers by giving them the right tools to help spread the good things." (Mr. 3, Organisation E-D, Green Belt).*

In a final input on customer satisfaction, another interviewee said:

- *"Linking Six Sigma with customer satisfaction is a perfect success step, providing the tools needed to meet real demand with high-quality products and services." (Mr. 1, Organisation S-P, Black Belt).*

6. F6 - Formation of Six Sigma organisational structure

Formation of Six Sigma organisational structure was in the 6th place as cited by 68 interviewees (91.89%). One interviewee stated that:

> *"By formation of the Six Sigma organisational structure, this can influence our success." (Mr. 2, Organisation S-A, Champion).*

Another remark on this:

> *"Formation of Six Sigma organisational structure was one of the significant CSFs of Six Sigma implementation in our organisation as in most of the Six Sigma organisations." (Mr.1, Organisation E-H, Black Belt).*

7. F15 - Project management skills

Project management skills was equal to the formation of Six Sigma organisational structure in the 6th place with 68 interviewees (91.89%). All interviewees believe that their organisations attempt to develop employees to give them opportunities to improve their skills by providing training courses and on the right subjects for their job description. Gathering skills is based on personal capabilities; some employees are familiar with being team members and that will make the learning stage fast and easy to achieve. Some of the interviewees said:

- *"We have some employees with enough skills to be a team member and work effectively in any future project. The possibility to develop those employees' skills is definitely easy to obtain." (Mr. 2, Organisation S-A, Champion).*

- *"Good managers must know their employees and which of them are capable to be effective members in a team project. We have some employees who have specific skills that can help us to fit them into such a project." (Mr. 1, Organisation E-C, Black Belt).*

- *"People sometimes think the Six Sigma process is more complicated than it really is." (Mr. 2, Organisation S-L, Master Black Belt).*

- *"The skills of Six Sigma can be taught easily, because the organisation has a training department that can design such a programme." (Mr. 1, Organisation U-E, Black Belt).*

- *"Gathering skills is based on personal capabilities; some employees are familiar with being team members and that will make the learning stage fast and easy to achieve." (Mr. 2, Organisation E-M, Black Belt).*

Finally, some problems created by age or aptitude were mentioned by one interviewee:

- *"Some employees are too old to learn new knowledge or skills; for example, they had difficulties when we launched the automated system. The problem is that the percentage of educated people is not high, so it is difficult for them to become team members in the Six Sigma project." (Mr. 1, Organisation E-B, Quality Manager).*

8. F13 - Integrating Six Sigma with rewards and recognition system

Interviewees have identified integrating Six Sigma with rewards and recognition system as the 8th most important factor behind the successful implementation of Six Sigma, as cited by 67 interviewees (90.54%). One of them said:

> *"We are working in an organisation that does grant benefits to such a project." (Mr. 2, Organisation U-C, Black Belt).*

Another reported:

> *"Our organisation is starting to have a very constructive discussion about rewards and recognition for Black Belts." (Mr. 1, Organisation S-H, Master Black Belt).*

And another interviewee said:

> *"To give rewards to our employees, we need to get promotion to a high level of management. Thus, it is difficult to encourage employees to join in on projects, but we can give them overtime hours for extra pay." (Mr. 1, Organisation S-B, COE).*

The fact is that most of us need a balance of internal satisfaction and external recognition if we are going to stay in a particular job for very long.

9. F5 - Effective communication

Effective communication was cited by 66 interviewees (89.19%) as the 9th most important factors in implementing a Six Sigma project. They agreed that there was no open door communication between the lower employee levels and top management at the division; projects are usually announced between the top management levels while ignoring the others and many were initiated without telling employees about objectives or benefits.

Communication is necessary to obtain better performance; unfortunately, personal relations are a strong issue in this kind of communication, which can give poor results. According to some interviewees:

- *"Communication is necessary to obtain better performance; unfortunately, personal relations are a strong issue in this kind of communication, which give poor results. And projects are usually announced between the top management levels, ignoring the others." (Mr. 1, Organisation U-H, Black Belt).*

- *"Good communication is important in business to individuals and their organisations because communication is everything." (Mr. 2, Organisation E-D, Black Belt).*

- *"In our organisation, we use various means of communication, such as regular meetings, Intranets, newsletters, posters, videos and open days for communication purposes, where all our employees can meet and talk with top management." (Mr. 1, Organisation E-F, General Manager).*

- *"Our organisation policy allows employees to communicate with all organisation levels easily; but we have a lack of project announcement." (Mr. 1, Organisation S-H, Master Black Belt).*

- *"We believe that communication is the sharing of ideas. Effective communication brings about positive change." (Mr. 1, Organisation S-A, Quality Manager).*

- *"We apply internal and external communication strategies to retain our relationships with our employees and customers." (Mr. 2, Organisation E-K, Senior Manager).*

- *"The importance of effective communications in all areas of business means that we tend to have good relationships between employees, for example." (Mr. 2, Organisation U-C, Black Belt).*

10. F11 - Integrating Six Sigma with financial goals

Interviewees have identified Integrating Six Sigma with financial goals as equal 9th to effective communication as the 9th most important factor behind the successful implementation of Six Sigma, as cited by 66 interviewees (89.19%). One interviewee stated that:

> *"Financial goals can make a lot of difference in an organisation." (Mr. 2, Organisation U-J, Black Belt).*

Another said:

> *"We achieve financial targets through Six Sigma projects, the organisation learns that improving our processes directly translates to positive financial return." (Mr. 1, Organisation S-E, Senior Manager).*

11. F9 - Integrating Six Sigma with employees

Integrating Six Sigma with employees was in the 11th place, as cited by 64 interviewees (87.84%). According to the Six Sigma literature, requirements and guidelines, employee involvement and participation at all levels are critical factors that influence the effectiveness of an organisation's Six Sigma efforts. Some of the Middle East organisations have an excellent system for their employees, the subjects fit well with the employees' job and they continue to improve employees' skills and their productivity. In contrast, some of them do not pay any attention to their employees, the subjects of their training do not fit with the employees' job and they do not have the right training strategy. For that reason, no employee has a clear policy on how to do his or her job, everyone is doing the same job in different ways and employees are always complaining.

The positive actions and attitude towards Six Sigma has resulted in increasing employee commitment to Six Sigma quality management, as was declared by some interviewees, as follows:

- *"Every employee in the organisation should know how he fits in the big picture and that is the first step to create Six Sigma quality culture in the organisation. It depends on policy deployments, awareness, participation, communication, recognition and rewards, which all create the quality culture, and build up feelings of belonging. to sustain it." (Mr. 1, Organisation E-F, General Manager).*

- *"When top management take care to create a quality culture, the employees will take care of the organisation. And this is what has been reached by strong support of our top management and I hope to sustain it." (Mr. 1, Organisation S-P, Black Belt).*

- *"Employee attitude has a positive effect on the quality culture after Six Sigma implementation." (Mr. 1, Organisation S-S, Master Black Belt).*

- *"The employees can make important contributions to the success of implementation efforts when they have the necessary power and skills and if they have been well trained in the use of tools and they are motivated and empowered." (Mr. 1, Organisation U-F, CEO)*

12. F19 - Use of external consultants

Use of external consultants was in the 12th place, as cited by 64 interviewees (86.49%). One interviewee stated that:

> *"During our implementation of Six Sigma, we needed to use some external consultants. They were very useful in the introducing, training*

and the implementation of the Six Sigma projects." Mr. 1, Organisation S-C, Champion).

Another interviewee said:

> *"From my experience, I think the use of the external consultants plays a significant role in the implementation of Six Sigma for any organisation implementing Six Sigma projects, especially in the early stages." (Mr. 2, Organisation S-L, Master Black Belt).*

13. F4 - Teamwork

Out of 74 interviewees, 62 (83.78%) agreed that teamworking is an important factor for successful implementation of Six Sigma in the Middle East. They agreed that it is important to identify teamworking skills among employees and develop their ability to improve them. One interviewee stated:

> *"Good teamwork is important. Many organisations recruit people with an aptitude for and leaning towards teamwork, our organisation is one of them." (Mr. 1, Organisation E-B, Quality Manager).*

Another said:

> *"Good teamwork behaviour is recognised and rewarded. Teamwork is built into the organisation culture." (Mr. 2, Organisation S-K, Green Belt).*

14. F12 - Integrating Six Sigma with existing initiatives

Integrating Six Sigma with existing initiatives was in the 8th place, as cited by 68 interviewees (91.89%). Six Sigma is an advanced quality initiative and should be preceded by other quality initiatives such as ISO-9000. This will help in developing a quality-oriented culture in the organisation and prepare the employees to adopt more complex initiatives like Six Sigma. One interviewee stated:

> *"Integrating Six Sigma with existing initiatives can improve our quality of services." (Mr. 1, Organisation S-P, Black Belt).*

And another said:

> *"Integrating Six Sigma with existing quality and improvement programmes helped us to introduce, evolve and improve our Six Sigma projects successfully and effectively." (Mr. 2, Organisation U-I, Master Black Belt).*

15. F17 - Integrating Six Sigma with information technology (IT) infrastructure

61 (82.43%) interviewees agreed that integrating Six Sigma with information technology (IT) infrastructure is an important factor for successful implementation of Six Sigma in the Middle East. One interviewee stated:

> "*Our organisation is integrating Six Sigma with information technology (IT) infrastructure and it believes and considers it as one of the CSFs of the successful implementation of Six Sigma.*" *(Mr. 3, Organisation U-A, Black Belt).*

Another interviewee said:

> "*Integrating Six Sigma with the IT is an important factor for successful implementation of a Six Sigma project for any organisation.*" *(Mr. 1, Organisation E-K, Quality Manager).*

16. F14 - Use of proper Six Sigma methodologies and tools

The use of proper Six Sigma methodologies and tools was in the 16th place of the critical elements in Six Sigma implementation, as cited by 59 interviewees (79.73%). Successful implementation of Six Sigma needs understanding, not only of statistics but also of using them to gain better results. The finding shows that the majority of respondents depend on statistical data to improve their performance. One interviewee stated that:

> "*Every business and industry relies on strategic methodology and tools to help fulfil a business's goals and objectives.*" *(Mr. 1, Organisation S-A, Quality Manager).*

Another interviewee said:

> "*Using proper Six Sigma methodologies and tools can guide an organisation toward its goals.*" *(Mr. 2, Organisation E-H., Green Belt).*

Six Sigma technologies and software tools enable organisations to design dynamic operational processes and make effective use of their human resources. However, there are important issues that need to be considered for the effective use of these tools, such as simplicity of technology, ease of use and friendly interface, suitability to employees' needs, reliability and security.

17. F18 - Competitive benchmarking for Six Sigma

56 interviewees out of the 74 (75.67%) cited competitive benchmarking for Six Sigma. Benchmarking is considered an activity that can be performed at all levels in an organisation. This is the advice of a Six Sigma expert during the interview,

> *"We should learn from others, and move faster; faster and faster. We are far behind." (Mr. 2, Organisation U-I, Master Black Belt).*

One interviewee stated that:

> *"My organisation had benefited from benchmarking the Six Sigma implementation from some competitive organisations that implemented successfully." (Mr. 2, Organisation S-G, Green Belt).*

Another said:

> *"I believe that the competitive benchmarking for Six Sigma plays a critical role in the successful implementation of Six Sigma projects in my organisation." (Mr. 1, Organisation S-O, Black Belt).*

18. F16 - Project prioritisation, selection, evaluation, tracking and reviews

The project prioritisation, selection, evaluation, tracking and reviews was in the 18th place of the critical elements in Six Sigma implementation, as cited by 54 interviewees (72.97%). Since a Six Sigma initiative is a project-based programme, the project selection is a significant factor in Six Sigma success. One interviewee stated that:

> *"We introduced several standards that linked to Six Sigma to enable more effective project selection, tracing and management." (Mr. 1, Organisation U-F, COE).*

Another interviewee said:

> *"Project prioritisation, selection, evaluation, tracking and reviews can deliver great value and low risk with available." (Mr. 1, Organisation S-G, Black Belt).*

19. F10 - Integrating Six Sigma with suppliers

As a result of the analysis, integrating Six Sigma with suppliers was in 19th place (last, but not least), as cited by 53 interviewees (71.62%). They agree on the importance of integrating Six Sigma with the suppliers. Middle East organisations appeared to apply partnership with their suppliers or try to open communications channels in order to integrate the Six Sigma with the suppliers, as pointed out by some interviewees as follows:

- *"Supplier performance can affect process such as quality." (Mr. 1, Organisation E-A, Black Belt).*
- *"Most problems can originate with suppliers, therefore Six Sigma integration with suppliers should be initiated." (Mr. 1, Organisation U-D, Master Black Belt).*
- *"Suppliers are crucial to please their organisations who are looking to ensure they are getting the best value from their suppliers." (Mr. 1, Organisation S-O, Black Belt).*
- *"We see our suppliers as partners, we work very close with them to improve quality and the exchange of information through joint problem solving, we trust each other and we built up confidence in a long-term relationship." (Mr. 1, Organisation E-F, General Manager).*
- *"We verify the capability of each supplier by conducting a comprehensive review of that supplier's business practices and inspection capabilities, and quality." (Mr. 1, Organisation S-E, Senior Manager).*
- *"Our suppliers know they have to comply exactly with agreed specifications and this releases us from in-bound inspection and the resultant delays in production." (Mr. 1, Organisation S-R, Champion).*

The final response was:

> *"Our organisation is so confident in the supplier's quality for one critical component that comprises 70 per cent of the total cost of supplier material, inventory has been reduced by 68 per cent, reduced the number of suppliers by 50 per cent, reduced the number of defects from suppliers by 90 per cent, and re-examined and eliminated unnecessary specifications." (Mr. 1, Organisation E-F, General Manager).*

7.3.4 Satisfaction with Six Sigma Implementation (Interview, Section 8)

The last main interview question was aimed to elicit the view of interviewees on the level of satisfaction with the results achieved from their implementation of Six Sigma projects in their organisations.

7.3.4.1 Tabular data presentation

Table 7.26 presents the analysis of responses, while Figure 7.26 gives a graphical presentation in the form of bar charts.

Table 7.26: Interviewees' organisation satisfaction with results achieved through Six Sigma programme implementation

Satisfaction level	Saudi Arabia		Egypt		UAE		**Overall**	
	No. of interviewees	%	No. of interviewees	%	No. of interviewees	%	**No. of interviewees**	**%**
Highly satisfied	20	80.00	19	73.08	22	95.65	**61**	**82.43**
Satisfied	3	12.00	4	15.38	1	4.35	**8**	**10.81**
Neutral	2	8.00	3	11.54	---	---	**5**	**6.66**
Total	25		26		23		**74**	

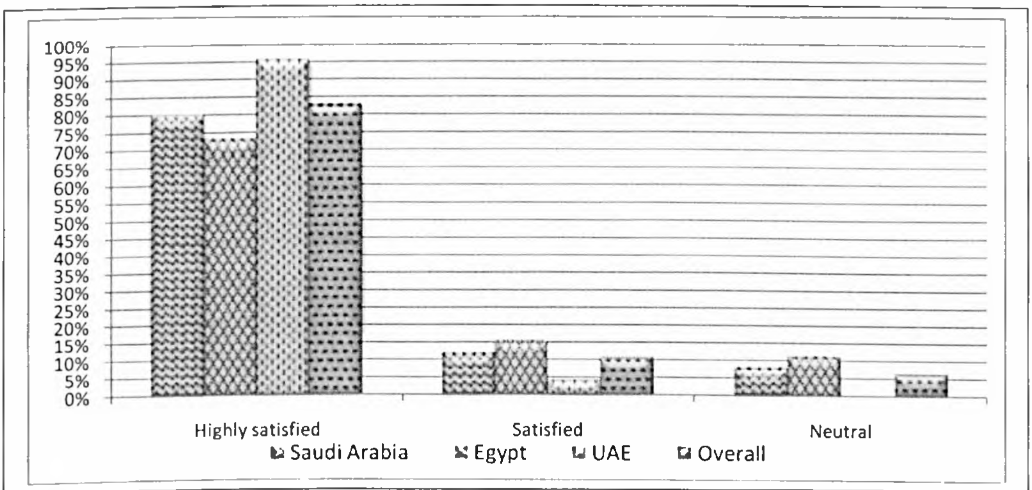


Figure 7.26: Interviewees' organisation satisfaction with results achieved through Six Sigma programme implementation

The analysis shows that, overall, most interviewees' organisations, 82.43% (61), were highly satisfied with their implementation of Six Sigma projects, 10.81% (8) were satisfied and 6.66% (5) were neutral. This implies that, in most cases, the organisations were achieving positive results from Six Sigma implementation.

7.3.4.2 Interviewees' quotations

The following is a view of interviewees on the level of satisfaction with the results achieved from their implementation of Six Sigma projects in their organisations (see Appendix F). Some interviewees said:

- *"Satisfaction in my organisation is very high, I think that it is achieving positive results from Six Sigma implementation." (Mr. 1, Organisation S-H, Master Black Belt).*

- *"For my organisation, I am sure it is very satisfied with the results achieved from the implementation of Six Sigma projects." (Mr. 3, Organisation E-N, Black Belt).*

- *"I think some organisations did great improvement on their processes' performance and identifying how they could be improved. This was something that was very important to them." (Mr. 2, Organisation S-K, Green Belt).*

He continued:

> *"Six Sigma is also something that is taught, as we think it is a good management method for promoting quality management. Actually, Six Sigma is very popular now as a management method across the Middle East and most of them are very satisfied with its results achieved, I think." (Mr. 2, Organisation S-K, Green Belt).*

And from another interviewee:

> *"Once organisations have reviewed their progress to date and identified their strategies for growth, organisations' existing business plan may look dated and may no longer reflect the business's position and future direction." (Mr. 1, Organisation U-K, Master Black Belt).*

Finally, one of the interviewees stated:

> *"In general, the concept of Six Sigma is a totally new concept in the Middle East but its implementation is satisfied." (Mr.1, Organisation S-J, Black Belt).*

7.3.5 Comments of interviewees (Interview, Section 9)

At the end, the interviewees were asked to make any comments they would like to share regarding the Six Sigma programme based on their experience of its implementation in their organisations. The important comments will be considered and discussed in the discussion of findings (Chapter 8) and in the conclusions and recommendations (Chapter 9).

7.4 Chapter Summary

This chapter has focused on the description and analysis of the qualitative data collected in this study by conducting 74 interviews in 37 organisations in the three Middle East countries in order to get a better understanding of the current status of Six Sigma in the Middle East context. It provided a brief account of the profile and background of the interviewees participating in the study by giving demographic data (characteristics of respondents and their organisations). Furthermore, it provided a full description and analysis of each key issue of Six Sigma implementation that related to the questions of the research interview and the research questions and objectives which are the reasons for/ benefits of Six Sigma implementation, the challenges of implementation, the CSFs for implementation and the satisfaction with implementation of Six Sigma in the Middle East.

The semi-structured interviews were intended to examine respondent considerations in greater depth concerning the key issues identified in the questionnaire. Analysis of these interviews added essential information to the study and brought to light important areas of differences and commonality among the 74 respondents interviewed concerning the key issues related to Six Sigma implementation in their organisations. The interviews were helpful in providing further information about how Six Sigma is actually implemented in the Middle East context.

Next, Chapter 8 provides a comprehensive discussion and interpretation of the findings in the context of both the quantitative and qualitative analysis presented in Chapter 6 and in this chapter, in order to obtain triangulation between the quantitative and qualitative data and the relevant literature.

CHAPTER 8

DISCUSSION OF FINDINGS AND PROPOSED MODEL

CHAPTER 8

DISCUSSION OF FINDINGS AND PROPOSED MODEL

8.1 Introduction

This chapter provides a comprehensive interpretation and discussion of the empirical findings of the questionnaires and the interviews presented in Chapters 6 and 7, respectively. First, discussion of the findings of the demographic data (Section 8.2). Second, discussion of the findings of the key issues of Six Sigma implementation related to the research questions (Section 8.3). Third, the proposal of a generic model for successful and effective Six Sigma implementation in the Middle East organisations (Section 8.4). Finally, there is a chapter summary (Section 8.5). Figure 8.1 shows the structure of the chapter.

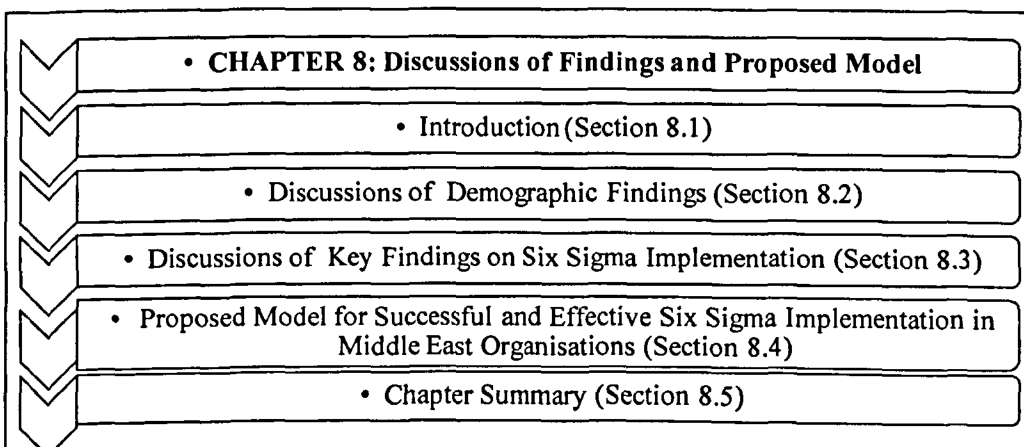


Figure 8.1: Structure of Chapter 8

8.2 Discussion of Demographic Findings

Based on the analysis of the demographic data (characteristics of respondents, interviewees and their organisations) of the questionnaire and semi-structured interview shown in Chapters 6 and 7, respectively, the findings provided more information and helped to understand their profiles in this study. The findings of the survey questionnaire and the semi-structured interview were in agreement, the interviews results were consistent with the questionnaire results, since the findings of the interviews support those of the questionnaire and provide more insights on the Six Sigma implementation in the Middle East. The findings of this study are generally consistent and coincide with previous studies and the literature on the identified key issues. A discussion of the demographic general findings now follows.

8.2.1 Findings from Profiles of Responding Organisations

As shown in Sections 6.2.1.1 and 7.2.1.1, regarding the willingness of the respondents and interviewees to name their organisations, the majority of them were willing to do so (see Tables 6.1 and 7.1 and Figures 6.2 and 7.2). However, in view of the unwillingness of some, the researcher did not therefore mention any names.

As reported earlier in Sections 6.2.1.2 and 7.2.1.2, 44 organisations from the three Middle East countries (Saudi Arabia, Egypt and the UAE) were surveyed and 37 of them also participated in interviewees (see Tables 6.2 and 7.2 and Figures 6.3 and 7.3). In addition, the results show that the majority of the organisations were from Saudi Arabia, followed by Egypt, then the UAE. This is because the researcher is from Saudi Arabia and was able to gain access to more of the Six Sigma organisations.

Six Sigma has been implemented in both manufacturing and services organisations in the three Middle East countries covered, as shown in Sections 6.2.1.3 and 7.2.1.3. Overall, the majority of organisations implementing Six Sigma in the Middle East were in the services sector (see Tables 6.3 and 7.3 and Figures 6.4 and 7.4). This indicates the maturity of the services sector in Six Sigma implementation in the Middle East countries. On the other hand, the difference between both Saudi Arabia and UAE and Egypt is related to the maturity of the two sectors in those countries, which is greater in the services sector than in manufacturing and the economy of the Middle East is oriented towards services rather than manufacturing.

Six Sigma has been implemented in both sizes of organisations: in large organisations (250 employees and over) and in the SMEs (fewer than 250 employees) in the three Middle East countries, as shown in Sections 6.2.1.4 and 7.2.1.4. The results indicate that it has been implemented by the large organisations more than by the SMEs (see Tables 6.4, 6.5, 7.4 and 7.5 and Figures 6.5 and 7.5).

Therefore the majority of organisations implementing Six Sigma are large ones with more than 250 employees.

8.2.2 Findings from Profiles of Individual Respondents and Interviewees

As shown in Sections 6.2.2.1 and 7.2.2.1, the majority of respondents and interviewees were willing to reveal their names but some were not (see Tables 6.6 and 7.6 and Figures 6.6 and 7.6), in spite of the researcher's promise not to mention names and that all information would be confidential (see the research questionnaire cover page, Appendix A). The researcher therefore did not mention any names of respondents and interviewees.

Regarding the nationalities of the respondents and interviewees, as shown in Sections 6.2.2.2 and 7.2.2.2, the percentages of questionnaire respondents overall were the same, with 50% nationals and non-nationals, while the interviewees were 55.41% nationals and 44.59% non-nationals (see Tables 6.7 and 7.7 and Figures 6.7 and 7.7). Since the Gulf Region depends on immigrant employees, the majority of respondents and interviewees in Saudi Arabia and the UAE were non-nationals, while Egypt depends overall on its own nationals rather than immigrants. This result indicates that the majority of Six Sigma immigrants in the Gulf Region is high in comparison with Egypt, so the Gulf Region should invest in developing Six Sigma skills in its own citizens.

For the organisational position of respondents and interviewees, as shown in Sections 6.2.2.3 and 7.2.2.3, they were in both positions: managerial and operational (see Tables 6.8 and 7.8 and Figures 6.8 and 7.8). Overall, the majority of the respondents and interviewees had managerial rather than operational positions in the three countries. It can be concluded that almost all of them were experienced practitioners at senior and executive levels. Therefore their responses can be considered as reliable and provide valuable information.

For their Six Sigma role, as shown in Sections 6.2.2.4 and 7.2.2.4, the respondents and interviewees were mainly top executive managers (CEOs, general managers), quality managers, Six Sigma Champions, MBBs, BBs and GBs. Overall, the majority of respondents and interviewees were BBs (see Tables 6.9 and 7.9 and Figures 6.9 and 7.9). It can be concluded that since different Six Sigma roles are available, this indicates that the hierarchy of Six Sigma roles is clear and, moreover, the Six Sigma BB role is the largest occupied by the respondents and interviewees, which confirms that the practices are well developed.

Regarding the time served in their organisation, as shown in Sections 6.2.2.5 and 7.2.2.5, overall, the respondents and interviewees have been working in their organisations for different lengths of time (see Tables 6.10 and 7.10 and Figures 6.10 and 7.10). The majority have been working in them for around 10 years. This indicates that they are thus aware of the present/current situation of their organisations.

About the Six Sigma certification/qualification, as shown in Sections 6.2.2.6 and 7.2.2.6, overall, most, if not all of the respondents and interviewees were certified/qualified and familiar with Six Sigma implementation, the majority of them with between 6 and 8 years' certification/qualification experience (see Tables 6.11 and 7.11 and Figures 6.11 and 7.11). These results are not surprising, since Six Sigma certification/qualification in the Middle East is still relatively new. More experience is required and preferred.

For involvement of respondents and interviewees in Six Sigma implementation projects, as shown in Sections 6.2.2.7 and 7.2.2.7, overall, the majority of them were involved in between 1 and 10 projects, (see Tables 6.12 and 7.12 and Figures 6.12 and 7.12). These results can be considered satisfactory, since Six Sigma implementation projects in the Middle East are still relatively new. Employee involvement is a crucial factor in successful Six Sigma implementation, because the environment of Six Sigma creation is unthinkable without such involvement.

8.2.3 Findings from Profile of Six Sigma Programme

As shown in Sections 6.2.3.1 and 7.2.3.1, although Six Sigma was pioneered in the mid-80s, it was mainly implemented by the Middle East organisations during or after 1999 (see Tables 6.13 and 7.13 and Figures 6.13 and 7.13). The majority of the organisations have been implementing a Six Sigma programme for about seven years. This indicates that those organisations could distinguish the requirements for Six Sigma implementation.

Regarding the primary responsible of the Six Sigma programme, as shown in Sections 6.2.3.2 and 7.2.3.2, in most case, it was responsible by external consultants, followed by directors (see Tables 6.14 and 7.14 and Figures 6.14 and 7.14). This indicates that they might still need external experts for planning, training, introduction and improvement of the Six Sigma projects' programme.

Before implementation of the Six Sigma programme have been started, many Middle East organisations had had experience of implementation of other quality programmes which could have influenced the current Six Sigma implementation projects. As shown in Sections 6.2.3.3 and 7.2.3.3, all the responding organisations had implemented one or more of the other quality improvement programmes (TQM, ISO-9000, BPR or Benchmarking) before embarking on the Six Sigma programme to measure their process performance and reach customer satisfaction (see Tables 6.15 and 7.15 and Figures 6.15 and 7.15). Respondents and interviewees were sure those initiatives can help in achieving the success of Six Sigma and have more significant positive influence on current Six Sigma implementation. This would be helpful in the successful implementation of Six Sigma in the Middle East. The results reveal and suggest that all these quality initiatives help in developing a quality-oriented culture in the organisation, an essential element of Six Sigma. Thus they pave the way for implementing Six Sigma. Therefore Middle East organisations could combine and integrate those initiatives with Six Sigma which would be helpful in its implementation. Overall, in all the Middle East organisations surveyed and interviewed, there was a strong view among them that the previous initiatives implemented had facilitated communication between management and employees and increased workforce involvement in problem-solving generally.

8.2.4 Findings from Profile of Six Sigma Implementation

Regarding the present status of Six Sigma implementation, as shown in Sections 6.2.4.1 and 7.2.4.1, most of the organisations are in the partially, DMAIC, stages of

Six Sigma implementation (see Tables 6.16 and 7.16 and Figures 6.16 and 7.16). It can be concluded that the majority (slightly more than half) of the responding organisations are in the mid-way, partially, DMAIC stages in Six Sigma implementation, then in full implementation and then in the starting stage.

For the current pre-DMAIC and DMAIC stages of Six Sigma implementation, as shown in Sections 6.2.4.2 and 7.2.4.2, overall, in the pre-DMAIC stages, the respondents' and interviewees' organisations were in the training and start-up stages. In addition, in the DMAIC stages, most of the organisations were in the analyse stage (see Tables 6.17 and 7.17 and Figures 6.17 and 7.17). This indicates that the Six Sigma implementation in the Middle East organisations is still in its early stage.

As shown in Sections 6.2.4.3 and 7.2.4.3, regarding the number of projects completed, overall, most of the organisations had completed 6-10 projects, followed by 11-15. No organisation so far had completed more than 40 projects (see Tables 6.18 and 7.18 and Figures 6.18 and 7.18). This indicates that a learning process and implementation for Six Sigma is under way.

Regarding the average time for completing implementation of Six Sigma projects, as shown in Sections 6.2.4.4 and 7.2.4.4, most of the respondents and interviewees reported an average of 4-6 months and/or 7-9 months (see Tables 6.19 and 7.19 and Figures 6.19 and 7.19). The average time depended on the nature and scope of the project and the experience of the Six Sigma team. It is important to highlight that when a project's time to completion increases, the tangible/intangible cost of the project deployment (due to labour and materials) will increase. The finding reinforces the argument that Six Sigma projects should be shorter to ensure continuous management support and consistent commitment of resources. They include frustration due to lack of progress, diversion of manpower away from other activities and delay in realisation of project benefits (Lynch *et al.*, 2003). When the project duration starts to exceed six months, these intangible costs may result in team member turnover, causing further delays.

As shown in Sections 6.2.4.5 and 7.2.4.5, regarding the percentage of employees involved in Six Sigma project implementation, the majority of organisations involved around 1-20% of their employees in the Six Sigma projects (see Tables 6.20 and 7.20 and Figures 6.20 and 7.20). This indicates that the Six Sigma programme has so far been focused on selected groups of people, which include the Champions, MBBs, BBs, GBs and team members. Some Middle East organisations placed greater emphasis on how employee engagement with and participation in Six Sigma had to evolve gradually and was brought about only through management's careful structuring and nurturing of the process.

Regarding the organisational resistance to Six Sigma implementation, as shown in Sections 6.2.4.6 and 7.2.4.6, overall, most of the organisations had not faced any resistance (see Tables 6.21 and 7.21 and Figures 6.21 and 7.21). No resistance is explained by the fact that most of the organisations had implemented other quality initiatives like ISO-9000, TQM, BPR, etc., before implementing Six Sigma, thus creating a culture and environment conducive to the new change initiative. So, previous quality programme implementations have a significant influence on the organisational resistance to Six Sigma implementation.

Finally, as shown in Sections 6.2.4.7 and 7.2.4.7, regarding the importance of use of external consultants, overall, the majority of respondents and interviewees see the use of external consultants to assist them in implementing Six Sigma as very important (see Tables 6.22 and 7.22 and Figures 6.22 and 7.22). The Middle East organisations used external consultants, mostly for training Six Sigma team members, to facilitate the implementation of Six Sigma. Since Six Sigma in most organisations was at its preparation phase of introduction, development and implementation, they required professional advice of external consultants who were mainly involved in training the Six Sigma teams and, in some cases, project planning and implementing Six Sigma methodology. Moreover, all organisations participating did rely on external consultants for formulating the Six Sigma strategy and plan since they planned and implemented their projects.

8.3 Discussion of Findings of Key Issues of Six Sigma Implementation

This section discusses the findings of key issues of Six Sigma implementation in the Middle East organisations related to the research questions and its objectives from the research questionnaire and the semi-structured interview. It important to highlight and note that the findings of the semi-structured interviews were in agreement and consistent with those of the questionnaires. In other words, the findings of the interviews support the findings of the questionnaire in providing more insights on the Six Sigma implementation in the Middle East. The slight inconsistency between the results for the criticality of the main issues can be attributed to the cultural differences that exist between countries. In addition, the findings of this study are generally consistent and coincide with previous studies and the literature on the identified key issues.

The discussion of the key findings of the quantitative and qualitative data analysis (Chapter 6 and 7, respectively) for reasons/benefits, challenges, CSFs, satisfaction level and accordingly proposed model of Six Sigma implementation can be summarised as follows.

8.3.1 Key Findings of Reasons for/ Benefits of Six Sigma Implementation

As stated in Section 1.4, one of the main objectives of this study was to explore and identify the major reasons for/ benefits of implementation of Six Sigma projects that encourage the Middle East organisations to implement them. So, this study identified 15 reasons/benefits (see Tables 6.24 and 7.24) to show why Middle East organisations implement a Six Sigma programme.

For the reliability (internal consistency) analysis (Table 6.23), since all the item-to-total correlations for the 15 reasons/benefits fell into the acceptable level (greater than 0.3) and all the Cronbach's α were greater than 0.7 (see Section 5.9.1), it seems that all the values can be considered as satisfactory (Nunnally, 1978). It could be concluded that there is a high internal consistency and therefore reliability and the instrument was therefore deemed reliable and should provide the expected results.

Regarding the descriptive statistics analysis (Table 6.24), the results show that all values of the mean of the 15 reasons/benefits were very high, indicating that these reasons/benefits are considered as having major importance in encouraging the organisations to implement Six Sigma projects. The qualitative analysis of the semi-structured interviews supported the data gained from the quantitative analysis of the survey questionnaire (see Tables 6.24 and 7.23). The findings also confirm that implementation of Six Sigma projects in the Middle East organisations is chosen for a variety of significant reasons/benefits, which vary from one organisation to another and from one country to another (see Tables 6.24 and 7.23).

Another important result from the analysis is the priority, i.e. all mean values are very close together. It might be due to the fact that almost all organisations found all the items to be critical in their implementation. The results of the study revealed that all three countries' organisations have slightly equal mean values of reasons/benefits and also that there are differences in the order and degree of emphasis among these reasons/benefits, depending on their criticality. Overall, the most reasons for/ benefits of Six Sigma projects' implementation in the Middle East were 'improving customer satisfaction (understanding customer needs and expectations)', 'improving business, financial performance and organisation efficiency', 'improving process performance continuously from reactive to proactive', 'building organisation reputation and creating new customer opportunities' and 'improving and increasing earnings, profitability and market share'. Furthermore, it is important to highlight that although organisations have some similarities, the reasons/benefits do not have the same prioritisation in all of them and also there were some differences in their ranking in the three countries (see Tables 6.24 and 7.23 and Figures 6.23 and 7.23).

Regarding whether there is a difference in the reasons for/ benefits of the Six Sigma implementation programme, the results of the significant differences analysis clearly revealed that (see Section 6.3.1.4):

- There is a significant difference ($P < 0.05$) in reasons/benefits between tangible and intangible perspective dimensions (see Table 6.26). This is because the intangible reasons/benefits' mean rank was higher than the tangible and this may indicate and explain the respondents' preference for intangible reasons/benefits over the tangible ones.

- There is no significant difference ($P > 0.05$) between the three Middle East countries (Saudi Arabia, Egypt and UAE) in reasons/benefits, except that in four, R/B2, R/B3, R/B6 and R/B7, there is a significant difference ($P < 0.05$). This indicates that the respondents in each country are equally satisfied with all reasons/benefits except those four. However, for the mean of all the reasons/benefits, there is no significant difference ($P > 0.05$) (see Table 6.27).
- There is no significant difference ($P > 0.05$) between the two sectors (manufacturing and services), except in two reasons/benefits (R/B3 and R/B14), where the difference is significant ($P < 0.05$) (see Table 6.28). This indicates that the respondents in both sectors are equally pleased with all reasons/benefits except for the four above. But for the mean of all the reasons/benefits, there is no significant difference ($P > 0.05$).
- There is no significant difference ($P > 0.05$) between the two organisation sizes (large and SME) and also for the mean of all the reasons/benefits ($P > 0.05$) (see Table 6.29). This indicates the two organisation sizes are implementing the Six Sigma programme for the same reasons/benefits.
- There is no significant difference ($P > 0.05$) between the two organisational positions (managerial and operational), except in one reason/benefit (R/B5). But for the mean of all the reasons/benefits, there is no significant difference ($P > 0.05$) (see Table 6.30). This indicates both organisational positions are satisfied with the same reasons/benefits.

One of the significant results of the reasons for/ benefits of the implementation programme is that, although a few significant differences were observed, all the other differences were not significant and it can be concluded that, generally, there are no significant differences in the reasons for/ benefits of the Six Sigma implementation programme between all the three Middle East countries (Saudi Arabia, Egypt and UAE), sectors (manufacturing and services), organisation sizes (large and SME) and organisational positions (managerial and operational).

Another significant result is that the correlation analysis clearly revealed that there was a statistically strong positive correlation between the reasons for/ benefits of the Six Sigma implementation perspective dimensions (tangible and intangible) (see Section 6.3.1.4.2 and Table 6.31).

The results clearly reveal that:

- A good reason/benefit influences positively Six Sigma project implementation, so reasons/benefits and the success of the Six Sigma project are positively linked.
- The reasons/benefits have a positive influence on successful implementation of a Six Sigma project. However, all reasons/benefits should be considered during all implementation stages of projects.
- Six Sigma cannot be successfully implemented without good reasons/benefits which are needed to implement it. Respondents and interviewees indicated and agreed on the importance of them for Six Sigma implementation.
- All the respondents and interviewees agreed that consideration of reasons/benefits is essential to achieve Six Sigma success.
- Most responding organisations recognise identifying good reasons for/ benefits of the implementation of the Six Sigma project to be crucial for successful Six Sigma project implementation.
- Nearly all respondents and interviewees agreed that all the 15 reasons/benefits identified were critical for their successful implementation of the Six Sigma project (see Section 6.3.1.2 and Table 6.24).

Most interviewees showed that the decision to implement Six Sigma was made when top management in most of the responding organisations realised the benefits that it can bring to an organisation. The Middle East organisations' top management were aware of the major benefits that would increase as a result of Six Sigma in customer satisfaction, cost savings, increased market share and profitability and improved product quality and services. Without belief in the tangible benefits of Six Sigma, organisations would not have invested the time and resources to make it work. This belief was a major force in creating top management commitment to and involvement in the implementation process. According to most interviewees, their organisations take advantage of the success of their implementation of Six Sigma. In addition, they feel that the organisations will not be able to derive full benefit from its implementation until they use Six Sigma in the correct way.

Overall, all respondents and interviewees were very positive about the business benefits to organisations of successfully implementing Six Sigma: its use was enabling organisations in the Middle East to participate more fully and effectively in the global economy. But some views were somewhat mixed on whether organisations were benefiting financially from Six Sigma, although it was noted that as it is still relatively new, more time is needed for there to be a clear impact on business profits. However, the interviewees generally shared the view that Six Sigma brings clear business benefits when properly implemented, especially improved efficiency. These benefits were attributed partly to factors such as the use of strategic planning and the review and continuous improvement of business processes under Six Sigma.

The interviews revealed that, for organisations in the Middle East, Six Sigma is often implemented as a means of improving business processes in order to compete more effectively in the global economy. Most of the interviewees observed that their organisations were effective in driving economic development and raising quality standards in their countries. Where rapid economic development is already occurring, it was noted that Six Sigma is often seen as a vehicle for ensuring that individual organisations improve their own business practices, remain competitive and thus benefit from their country's development.

It is important to highlight that in some cases such as UAE, it was noted that the government itself was playing an active role in promoting Six Sigma for these kinds of reasons/benefits and that government policy was therefore a main factor encouraging the implementation, especially in the public sector. In addition, another important factor driving it in the Middle East countries represented by the interviewees is the prestige associated with implementing Six Sigma and the benefits that this is likely to bring in terms of increased business. This was particularly notable in many organisations in the Middle East. Furthermore, the majority of interviewees indicated that organisations generally chose to implement a Six Sigma programme because of the reflection of the values or approach in business.

8.3.2 Key Findings on Challenges of Six Sigma Implementation

Another of the main objectives of this study was to explore the challenges facing Six Sigma implementation in the Middle East organisations and those need to be considered before it is implemented (Section 1.4). During this research, as implementing Six Sigma is a relatively new approach in the Middle East, it was found that it commonly encountered 13 challenges (see Tables 6.33 and 7.24).

For the reliability (internal consistency) analysis of the challenges of Six Sigma implementation in the Middle East organisations (Table 6.32), all the item-to-total correlations for the 13 challenges fell into the acceptable level (greater than 0.3) and also all the Cronbach's α were greater than 0.7 (see Section 5.9.1). However, it seems that all the values can be considered as satisfactory (Nunnally, 1978). This indicates high internal consistency and therefore reliability, so the instrument was therefore deemed reliable and should provide the expected results.

Regarding the descriptive statistics analysis (Table 6.33), the results show that all values of the mean of the 13 challenges were very high, which indicates that these challenges are considered as the most important for organisations in implementing Six Sigma projects in the Middle East. The qualitative analysis of the interviews supported the data gained from the quantitative analysis (see Tables 6.33 and 7.24). Another important result from the analysis is the priority, i.e. all mean values are very close together. It might be due to the fact that almost all organisations found all the items to be critical in their implementation. The results of the study revealed that all three countries' organisations have slightly equal mean values of challenges and also that there are differences in the order and degree of emphasis among these challenges, depending on their criticality.

The findings confirm that the Middle East organisations face several challenges which vary from one organisation to another and from one country to another. Overall, the most significant challenges were lack of top management commitment and support, lack of communication, selecting suitable projects, organisational resistance (fear of change) and insufficient training. Furthermore, it is important to highlight that although organisations have some similarities, the challenges do not have the same prioritisation in all of the organisations and also there were some differences in their ranking in the three countries.

Regarding whether there is a difference in the challenges of the Six Sigma implementation programme, the results of the significant differences analysis clearly revealed that (see Section 6.3.2.4):

- There was a highly significant difference ($P < 0.05$) in challenges between managerial and technical perspective dimensions (see Table 6.35). This indicates different aspects of Six Sigma influence different sectors.
- There is no significant difference ($P > 0.05$) between the three Middle East countries. Also, for the mean of all the challenges, there is no significant difference ($P > 0.05$) (see Table 6.36). This indicates the three countries are similarly affected by the challenges.
- There is no significant difference ($P > 0.05$) between the two sectors (manufacturing and services), except in two challenges (C4 and C13) ($P < 0.05$). But for the mean of all the challenges, there is no significant difference ($P > 0.05$) (see Table 6.37). This indicates both sectors mostly reflect identical challenges.
- There is no significant difference ($P > 0.05$) between the two organisation sizes (large and SME) and also for the mean of all the challenges, there is no significant difference ($P > 0.05$) (see Table 6.38). This indicates the two organisation sizes are not crucial with respect to the challenges.
- There is no significant difference ($P > 0.05$) between the two organisational positions (managerial and operational). Also, for the mean of all the challenges, there is no significant difference ($P > 0.05$) (see Table 6.39). This indicates both organisational positions mostly reflect identical challenges.

So, generally, although a few significant differences were observed, all the other differences were not significant, and it can thus be concluded that there was no significant difference in the challenges of the Six Sigma implementation programme between all the three Middle East countries (Saudi Arabia, Egypt and UAE), sectors (manufacturing and services), organisation sizes (large and SME) and organisational positions (managerial and operational).

Another significant result of the challenges is that the results of the correlation analysis clearly revealed that there was a statistically strong positive correlation between the challenges' dimensions (tangible and intangible) of the Six Sigma implementation (see Section 6.3.2.4.2 and Table 6.40).

Clearly, the study result confirms and emphasises that:

- Challenges of Six Sigma are instrumental in the successful implementation of Six Sigma.
- The challenges influence positively the successful implementation of the Six Sigma project. However, all challenges should be considered during all implementation stages.
- Most, if not all, respondents and interviewees agreed that all the 13 challenges identified were critical for their successful implementation of the Six Sigma project achieved in their organisations (see Section 6.3.3.2 and Table 6.24). In addition, they believe that Six Sigma cannot be successfully implemented without proper solution of the challenges and they indicated and agreed on the importance and essential need for providing a proper solution to challenges in Six Sigma implementation to achieve Six Sigma success (see Section 7.3.2.2).

Therefore, like Six Sigma reasons/benefits, its challenges are expected to affect implementation. The challenges have a direct effect on the implementation of Six Sigma as well as an indirect effect through their influence on perceived relative advantage of using Six Sigma. The study revealed that some of the common potential challenges encountered can acted as an obstruction to successful implementation in the Middle East organisations.

The research revealed that a good Six Sigma implementation does not bring success to the organisations if they are lacking top management commitment and support. Furthermore, most of the Middle East organisations gave necessary priority to Six Sigma implementation to gain internal commitment and support of top management essential for the survival of any improvement project of a Six Sigma initiative.

Cultural change requires having a clear communication plan and channels, motivating individuals to overcome resistance and educating senior managers, employees and customers on the benefits of Six Sigma. Announcing the results of Six Sigma projects, including successes, obstacles and challenges, will help future projects to avoid making similar mistakes and adopt only the very best practices. Lack of measurement and customer satisfaction are recognised as the major challenges to Six Sigma implementation in Middle East organisations.

The interviewees also highlighted the availability of support and resources and advised that organisations considering implementing Six Sigma should take advantage of these, as well as networking and learning from the experiences of other organisations in their region and further afield. In this respect, the important role of benchmarking was noted. The researcher thinks that learning from the experiences of other Six Sigma organisations, especially from their problems and finding out how they solved them, is important. In addition, he thinks that being able to network with other organisations and compare experiences can be very useful. He truly believes that these were very important in driving forward the progress of Six Sigma initiative. If Middle East organisations can see that Six Sigma is being used successfully to improve business in the Middle East context, they will certainly follow.

Most interviewees believe that if the project teams have enough experience to run the project and they have a clear process with transparency in communication, then they may implement the Six Sigma project successfully.

The Middle East interviewees show that certain employees are sufficiently involved during the commencing of Six Sigma quality projects in most of the organisations, which means that issues affecting employees are being given appropriate attention. This, in turn, has serious implications for the success of the Six Sigma implementations in the Middle East.

The interviewees highlighted the need to create an organisational culture which is honest and transparent and in which the views of all employees are welcomed and taken into account. Again, it was recognised that this can be difficult in Middle East societies with traditionally hierarchical or authoritarian business cultures or where courtesy is a very important social value. An employee empowerment and involvement framework is not effective unless employees have received formal systematic training in the Six Sigma quality management system.

Employee resistance is a big challenge in Middle East organisations because, generally, most of the employees do not like changes in job style. They may not contribute to such a project and in the researcher's opinion the reason is the lack of rotation and team work involvement. If organisations select new employees with two to four years' experience of Six Sigma projects, they may succeed more quickly, because they want to improve and take responsibility in such a project, so employees' resistance would be solved. With a good reward system, they could easily overcome this kind of challenge. It is a challenge to change employee culture because most employees cannot accept any changes. The other reason is that some employees worked in one place for a long time and the job process becomes part of their daily routine, so they cannot easily accept the change.

It important to highlight that there are many challenges that cause delay in implementing Six Sigma in the Middle East organisations. All of them have to be effectively considered in implementation and the chances of success can also be improved once an organisation's employees see that Six Sigma projects are beginning to generate financial results. These challenges represent a real threat to any Six Sigma project for any organisation planning to transform its business towards a Six Sigma initiative. Therefore, in order to be able to create a successful Six Sigma, Middle East organisations must try to overcome the above challenges.

The researcher believes that whenever there is a lack of complete commitment of the top management, this would be followed by negative consequences such as a lack of employees' involvement, lack of incentives and motivations, inadequate resources, employee resistance to change, inadequate performance evaluation, lack of customer care and lack of continuous improvement. And without commitment, support and involvement, no organisation can proceed in implementing any project of Six Sigma.

The researcher would highlight that Middle East organisations did not face strong challenges preventing them from implementing a Six Sigma initiative and ending by not implementing it but trying hard to sustain what they have reached in a very highly competitive environment. Sustaining the Six Sigma quality improvement will be the big challenge for Middle East organisations. Because of the high competition in the Middle East environment, business success of organisations must get better and better in providing products and services to stay in a good competitive position. In most of the Middle East organisations, the major challenges of Six Sigma implementation are coming from the traditional culture of hierarchical, bureaucratic and authoritarian organisational structure. Finally, for Middle East organisations to implement their Six Sigma programmes successfully and effectively, the challenges above should be analysed, solved and eliminated.

8.3.3 Key Findings on Critical Success Factors of Six Sigma Implementation

To explore and identify the major CSFs of Six Sigma implementation within the Middle East industry was another of the main objectives of this study, as shown in Sections 1.4, so it focused on the CSFs that helped organisations to implement a Six Sigma project successfully and effectively.

In the reliability (internal consistency) analysis for the main CSFs of Six Sigma implementation (Table 6.41), all the item-to-total correlations for the 19 CSFs fell into the acceptable level (greater than 0.3) and, also, all the Cronbach's α were greater than 0.7 (see Section 5.9.1). It could therefore be concluded that there is high internal consistency and therefore reliability, so the instrument was therefore deemed reliable and should provide the expected results.

Regarding the descriptive statistical analysis (Table 6.42), the values of the mean of the 19 CSFs were very high, indicating that all these CSFs are considered as the most important CSFs for successful implementation projects in the Middle East and through their importance in the success of Six Sigma implementation they must be in place in all implementation stages. This result exactly matched those of authors in the literature review (Eckes, 2000; Harry and Schroeder, 2000; Pande *et al.*, 2000). Although each factor is important on its own, the factors are also highly interdependent and failure to maintain one factor may have a negative impact on the overall Six Sigma project. If any of the CSFs is missing during the implementation stages, it would then make a difference between a successful implementation and a possible waste of resources, effort, time and money.

The study findings confirm that the 19 CSFs identified are critical for successful implementation of Six Sigma projects in the Middle East organisations. The qualitative analysis of the interviews supported the data gained from the quantitative analysis (see Tables 6.42 and 7.25) and any organisation should consider them as first priorities in its Six Sigma project.

Another important result from the analysis is the priority, i.e. all mean values are very close together. It might be due to the fact that almost all organisations found all the items to be critical in their implementation. The results of the study revealed that all three countries' organisations have slightly equal mean values of CSFs and also that there are differences in the order and degree of emphasis among these factors, depending on their criticality. Furthermore, it appeared that although organisations have some similarities, the CSFs do not have the same prioritisation in all of the organisations. Also, there are slight differences in the order and criticality of prioritisation of these CSFs from one country to another or from one organisation to another.

Regarding whether there is a difference in the CSFs of the Six Sigma implementation programme, the results of the significant differences' analysis clearly revealed that (see Section 6.3.3.4):

- There is a highly significant difference ($P < 0.05$) between CSF perspective dimensions (soft and hard) (see Table 6.44). This is because the soft CSFs' mean rank was higher than the hard CSFs' and this may be indicated and explained by the respondents' preference for soft CSFs over the hard ones.
- There is a highly significant difference ($P < 0.05$) between CSF perspective categories (people, organisation and technologies) (see Table 6.45). This indicates that different categories of Six Sigma for each organisation influence different CSFs.
- There is no significant difference ($P > 0.05$) between the three Middle East countries (Saudi Arabia, Egypt and UAE), except in three CSFs (F10, F17 and F19) (see Table 6.46). This indicates that they are all satisfied with all the CSFs

except the three factors. However, for the mean of all the CSFs, there is no significant difference ($P > 0.05$) between the three Middle East countries.

- There is no significant difference ($P > 0.05$) between the two sectors (manufacturing and services), except in two CSFs (F3 and F19) (see Table 6.47). The two sectors thus reflected identical CSFs apart from the two factors. But for the mean of all the CSFs, there is no significant difference ($P > 0.05$) between the two sectors.
- There is no significant difference ($P > 0.05$) between the two organisation sizes (large and SME), and also for the mean of all the CSFs ($P > 0.05$) (see Table 6.48). This indicates that the two organisation sizes are similarly satisfied with all the CSFs.
- There is no significant difference ($P > 0.05$) between the two organisational positions (managerial and operational), except in one CSF (F11) (see Table 6.49). This indicates that all the CSFs are satisfied by the two organisational positions except F11. For the mean of all the CSFs, there is no significant difference ($P > 0.05$).

The slight difference between the results for the Middle East organisations for the criticality of the factors can be attributed to the cultural differences between them. So, generally, although a few significant differences were observed, all the other differences were not significant and it can be concluded that there were no significant differences in CSFs of the Six Sigma implementation programme between all three Middle East countries (Saudi Arabia, Egypt and UAE), sectors (manufacturing and services), organisation sizes (large and SME) and organisational positions (managerial and operational).

Therefore, the results of the correlation analyses (Section 6.3.3.4.2) clearly revealed that there was a statistically strong positive correlation between the CSF perspective dimensions (soft and hard) (see Table 6.50), between the perspective categories (people, organisation and technologies) (see Table 6.51), between the CSF perspective dimensions (soft and hard) and the perspective categories (people, organisation and technologies) (see Table 6.52), between the reasons/benefits and the CSFs (see Table 6.53), and between the challenges and the CSFs (see Table 6.54).

Clearly, the study results emphasise that:

- CSFs of Six Sigma are instrumental in the successful implementation of Six Sigma.
- Most responding organisations recognise the CSFs to be crucial for Six Sigma.
- CSFs affect the implementation of the Six Sigma project and there is a positive correlation between the CSF dimensions (soft and hard).
- The CSFs are related almost entirely to people, organisation and technologies and they are highly interdependent.
- CSFs of Six Sigma in the Middle East have a positive influence on the level of satisfaction.
- Reasons/benefits and challenges are positively correlated with the CSFs and this supports the model proposed in this study.
- Customer satisfaction has been significantly improved after Six Sigma implementation and the respondents think that their overall customer satisfaction has been increasing.
- Consideration of CSFs is viewed as critical and essential to achieve successful Six Sigma implementation.
- All responding organisations agreed that all the 19 CSFs identified were very critical for their successful implementation of the Six Sigma project in the Middle East context (see Section 6.3.3.2 and Table 6.25).
- All CSFs for Six Sigma influence positively the successful implementation of the Six Sigma project and they are positively linked (see Section 6.3.3.4.2).
- Soft factors are more important and must be in place in the initial stage, while hard technologies' factors have also been put forward as independents in the successful and effective implementation of Six Sigma, which are important but not essential until after the soft factors are in place.
- The influence of CSFs on the successful and effective implementation of Six Sigma empirically is very critical in the Middle East context.

CSFs for Six Sigma implementation of this study are generally in agreement, consistent and match with previous findings in the literature review (Henderson and Evans, 2000; Wyper and Harrison, 2000; Goldstein, 2001; Antony and Banuelas, 2002; Coronado and Antony, 2002; Lee, 2002; Sandholm and Sorqvist, 2002; Byrne, 2003; Johnson and Swisher, 2003; Anbari and Kwak, 2004; Antony, 2004; Antony and Fergusson, 2004; McAdam and Evans, 2004; Antony *et al.*, 2005; Hendry, 2005; Antony, 2006; Kwak and Anbari, 2006; Antony *et al.*, 2007; Chakrabarty and Tan, 2007; Shahin, 2007). It is clear that they share most common factors. The current research CSF findings were quite similar to the results of Antony (2004), with some changes in the order of importance, although his were based on British organisations. On the other hand, there are common factors. For example, effective communication is identified as one of the most important, as well as training and teamworking experience. One important finding is that rewards and recognition may lead to sustained energy among project team members. We find that the results are consistent and share most common factors while differing in others. Differences between Antony's (2004) findings and this research were mostly related to the degree of significance given to the identified factors because his study was based on 24 respondent organisations whereas this study's findings are based on the 44 Middle East ones. Overall, the comparison reveals that most Six Sigma literature shares the same perceptions regarding CSFs.

It was not surprising that top management commitment and support has been identified in this research as the most important factor for successful and effective Six Sigma implementation in the Middle East and most authors and researchers of Six Sigma (Eckes, 2000; Harry and Schroeder, 2000; Pande *et al.*, 2000) in the literature review agreed with this. Top management plays a vital role in successful and effective Six Sigma implementation not only in beginning but also during the whole project. Without the commitment, support and involvement of top executive management, Six Sigma practices are difficult to maintain and without focus and direction from them, the project will be seen as just another management fad. Based on these findings, it can be argued that top management commitment supports and influences positively the success of Six Sigma project implementation.

Primarily, all organisations under study strongly agreed that having top management support and commitment was an important condition for success. Top management have supported the acceptance of the Six Sigma system in the organisations and all interviewees stated that top management support was indispensable to achievement of that success. Middle East top management have shown a different good picture of Six Sigma implementation in their countries and most of the interviewees confirmed that Six Sigma has recently become very popular in Middle East organisations.

Top management commitment is central in Six Sigma implementation and seems to be the most important of the CSFs for its successful strategic quality management concept and principle, and Six Sigma also contains the idea that top management commitment through processes is required if excellent performance results are to be delivered. The Middle East organisations' top management expressed a high commitment to quality management. They were knowledgeable and had strong awareness and were willing to take responsibility for quality improvement. Ultimately, it is management's responsibility to lead the organisational change required for Six Sigma success.

It is clear from the qualitative and qualitative analysis of Middle East organisations that the top management in these organisations was very much involved in introducing the Six Sigma programme into their organisations through clear vision and consistent support during the whole journey of implementation and improvement to reach a high level of quality maturity leading to reaching their successful implementation of Six Sigma in their organisations.

Most of the responding organisations have strong support from top management as being the key factor for the effective introduction and implementation of Six Sigma. But the question is 'Is this support proper and strong enough to develop the organisation's Six Sigma implementation?' Without the support and involvement of executive management, Six Sigma practices are difficult to maintain and without focus and direction from top management, the project will be seen as just another management fad.

It is clear from the study findings that all organisations strongly emphasised the CSFs of Six Sigma implementation and recognised the vital role of top management and their continued support and involvement for a successful Six Sigma implementation. Every organisation depends on its customers. Without satisfied customers, the organisation cannot exist. Therefore customer satisfaction is an important requirement of a Six Sigma programme.

A number of the interviewees highlighted that once an organisation has decided to implement Six Sigma, it is likely that top senior management have to be supportive of the initiative. It then becomes crucial to convince people of its value and personnel play a central role both in communicating the Six Sigma message throughout the organisation and implementing its principles in day-to-day work.

Six Sigma is a breakthrough management strategy which requires changes in organisational culture and in the attitudes of employees. Culture change is essential to prepare an organisation to achieve successful Six Sigma implementation and an effective change culture will ensure a smooth implementation of Six Sigma with minimum resistance. Six Sigma is not only a statistical or technical component, it is a cultural component. The cultural component of Six Sigma must always be accounted for in the implementation and people involved must be allowed sufficient time to work on their allocated projects. For a full and successful implementation of Six Sigma, organisations must take the cultural component into consideration.

Changing the culture of the organisation was one of the most important CSFs in the Middle East. The employees there do not realise that Six Sigma cannot be successfully implemented without culture change and the Six Sigma team are agents of change who should spread the Six Sigma philosophy throughout the organisation. All Middle East organisations in this research agreed that a change culture is essential to achieve Six Sigma success and the study results show that the change factor affects the implementation of the Six Sigma system and that there is a strong positive correlation between successful Six Sigma and effective change culture of organisations. Determining cultural readiness, whether an organisation is ready or not to embark on a Six Sigma initiative, is important. The timing and readiness of the organisation to implement Six Sigma are very significant.

Most of the interviewees mentioned that changing culture is not easy and it takes a few years. They stressed the need for complete organisational culture change and new ways of thinking. In almost all the Middle East, particularly in Saudi Arabia, Egypt and UAE, cultural issues are becoming more open and transparent, with extensive Six Sigma training taking place for organisational members at all levels of seniority. In the light of the researcher's own experience, it depends on the country first, then on the personality of employees and thirdly on the strength of the organisation. The main factor that could help an organisation is motivation of people. It is important to first consider the organisation's cultural environment before implementing Six Sigma. Organisations wanting to implement the Six Sigma organisation must take responsibility for bringing about the change in mindset required to implement Six Sigma. In the light of the researcher's own experience, it depends on the country first, then on the personality of employees and thirdly on the strength of the organisation. The main factor that could help an organisation is motivation of people. It is important to first consider the organisation's cultural environment before implementing Six Sigma. Organisations wanting to implement the Six Sigma organisation must take responsibility for bringing about the change in mindset required to implement Six Sigma.

All respondents and interviewees agreed that it is essential for organisations to emphasise and focus on changing organisation culture, as without change in employee knowledge, skill and behaviour on the job, change in technology, processes and structures is unlikely to yield long-term benefits. Success does not just happen; it needs a systematic, integrated, consistent and organisation-wide approach, which can only be achieved through total planning. Plans should specify who is responsible for achieving each result, including goals and objectives, and completion dates should be set. Responsible parties should regularly review the status of the plan.

Six Sigma is not only a statistical or technical component, it is a cultural component. The cultural component of Six Sigma must always be accounted for in the implementation and people involved must be allowed sufficient time to work on their allocated projects. For a full and successful implementation of Six Sigma, organisations must take the cultural component into consideration.

For a successful implementation of Six Sigma in the Middle East, the cultural component of Six Sigma must always be accounted for in the implementation and people involved must be allowed sufficient time to work on their allocated projects. The successful and effective implementation of Six Sigma does not come easily and is driven by its CSFs, which play an identical role to input variables of any project for the effective implementation of the Six Sigma programme. The change culture strategy should cover many aspects, like communication, user involvement and formal training and education of all users at all levels.

All interviewees highlighted that the creation of a Six Sigma culture is neither fast nor easy. It takes a long time to achieve cultural transformation and some organisations may take years to achieve cultural transformation for Six Sigma. But it depends on the degree of current efficiency and effectiveness in the organisation and of course on the high degree of commitment of top management and employees alike.

The best practice of Six Sigma implementation emphasised employee involvement. Effective Six Sigma implementation is not possible unless top management empower employees and show a strong commitment to the organisation. Top management alone cannot lead the change to Six Sigma culture and transfer their organisations to a better position without involving the rest of the organisation and starting to be more open in style, coming down from their ivory towers of management and getting their people involved in daily improvement and decision-making.

The study revealed that the right people at the right time are crucial for building and sustaining an organisation's competencies for successful implementation of Six Sigma projects. The prioritisation and selection of good Six Sigma projects to be worked on is vital to the success of the Six Sigma programme. Most interviewees illustrated the importance of using statistical data of Six Sigma to measure current performance and said that the availability of data assists in obtaining better performance.

The findings from the analysis of quantitative and qualitative data show clearly that employees are sufficiently involved in the Middle East daily activities. This means that issues affecting employees' involvement are being given appropriate attention. This could cause a major success of any Six Sigma projects. Only when top management is committed and all employees are involved can the organisation's vision be fulfilled and every employee in the organisation knows what is expected of him/her. Then the improvements will become daily practice and the organisation can create a new quality culture.

From the interviews, moderate evidence was gathered for receptivity to employee participation and empowerment, a systemic approach, awareness of customer requirements and preferences, reward and recognition systems and effective communications. In addition, interviewees highlighted the importance of employee participation and empowerment in successful Six Sigma. It requires extensive reorganisation of working practices, e.g. team-working and training to support it.

All interviewees from the Middle East organisations emphasised that Six Sigma implementation cannot be successful without the active participation of the employees and support of their top management. It was obvious that quality initiatives in these organisations were fully supported and led by top management, according to the interviewed managers quoted below. Without sufficient planning, preparation, commitment and support, top management are not likely to perform their roles in leading their organisations towards Six Sigma implementation.

Employee empowerment is a new way of managing organisations towards a more complex and competitive future. A Six Sigma strategy is deemed to fail if the empowerment of employees is absent. To be an effective organisation, employees should be given power, information, knowledge, rewards and recognition that are relevant to business performance. Most Middle East organisations get their employees involved, delegate some authority to them and reward them. There is moderate evidence of reward and recognition systems and when introduced, they are in order to help motivate more junior employees. Effective communications were also cited as important.

Employee involvement requires many changes in the existing organisation practices and culture. Some Middle East organisations have achieved a close relationship between employees and managers. The policies in these organisations promoted teamwork and involvement. All responding organisations emphasised the role of top management in the achievement of successful employee involvement. In addition, the majority of organisations had made some efforts to bring about the changes in management approaches felt to be required.

Awareness training is a critical first step; employees need to know how to change or what to do differently for Six Sigma quality improvement to happen. Training needs to be provided in problem identification and solving skills, how to communicate effectively and how to ensure that teamwork and decision making foster continuous improvement.

The majority of respondents and interviewees in Middle East organisations indicated that there was good awareness of Six Sigma principles, especially at high management level. Middle East organisations have to be always looking for improvement; they have to be trying to prevent problems and errors, rather than simply fixing them. In addition, they have to use cross-functional teams with representation from a number of units or levels in the organisation to make the whole organisation push in one direction, which is improvement and customer satisfaction.

The results from the quantitative analysis found that Middle East organisations provide enough training in Six Sigma for employees. Because of this, many employees could be skilled with Six Sigma tools and techniques. Several authors have also revealed that training and education are critical to successful Six Sigma implementation (Henderson and Evans, 2000; Wyper and Harrison, 2000; Goldstein, 2001; Antony and Banuelas, 2002; Coronado and Antony, 2002; Lee, 2002; Sandholm and Sorqvist, 2002; Byrne, 2003; Johnson and Swisher, 2003; Anbari and Kwak, 2004; Antony, 2004; Antony and Fergusson, 2004; McAdam and Evans, 2004; Antony *et al.*, 2005; Hendry, 2005; Antony, 2006; Kwak and Anbari, 2006; Antony *et al.*, 2007; Chakrabarty and Tan, 2007; Shahin, 2007). Most of the respondents acknowledged that their organisations have spent time and money on training programmes, especially technical training. The training content, timing, length and methods were well designed to cover the real training needs and training was undertaken with no real solid objectives to fulfil.

Continuous training and education of employees on Six Sigma are critical to its success. So, once the Six Sigma infrastructure is defined with the assistance of persons with adequate experience of Six Sigma, training may begin. Without proper trainers and training procedures, Six Sigma creation would not be possible.

As discussed previously, Six Sigma is essentially a new approach for Middle East organisations. Consequently, employees' training and education initiatives may help facilitate this change by providing employees with the skills they require to adapt to and to lead this change process. All respondents and interviewees indicated and agreed about the importance of training for most organisation members concerning Six Sigma in terms of concepts and philosophy. Without proper training, successful implementation of Six Sigma would not be possible. Suitable training should play an important role in the success of Six Sigma. Training for communication, training for teamwork and rewarding training effort with major emphasis on lower-level organisation member empowerment characterised organisations which were viewed as the most valuable in being recognised for highly successful Six Sigma implementation. In addition, they had recognised the importance of continuous improvement and demonstrated the desire for improvement of quality.

Training and education give a clear sense for employees to better understand the fundamentals, tools and techniques of Six Sigma. Training is part of the communication techniques to make sure everybody in the organisation is applying and implementing the Six Sigma techniques effectively.

Six Sigma is not only a statistical or technical component, it is a cultural component. The cultural component of Six Sigma must always be accounted for in the implementation and people involved must be allowed sufficient time to work on their allocated projects. For a full and successful implementation of Six Sigma, organisations must take the cultural component into consideration.

All respondents indicated the importance of training for most organisation members concerning the Six Sigma with regard to concepts and philosophy. Training for communication, training for teamwork and rewarding training effort with major emphasis on lower-level organisation member empowerment characterised organisations which were viewed as the most valuable in being recognised for highly successful Six Sigma implementation. In addition, they had recognised the importance of continuous improvement and demonstrated the desire for improvement of quality. Without proper training, successful implementation of Six Sigma would not be possible. Suitable training should play an important role in the success of Six Sigma.

Six Sigma experts are emphasising that it will be difficult if not impossible to meet and exceed the expectations of the external customers if attention is not paid to internal customers (employees). According to Dahlgaard *et al.* (2002), "Before you can satisfy external customers, however, you must first eliminate some of the obstacles to the internal customers (i.e. the employees) and create the conditions necessary for them to produce and deliver quality."

All Middle East organisations surveyed have developed and organised training programmes to equip their employees with up-to-date and relevant knowledge, skills and abilities to implement the Six Sigma successfully and effectively. In most Middle East organisations, training to introduce Six Sigma was limited to employees who were expected to follow the implementation of Six Sigma with the consultant.

Middle East organisations should learn how to transform their manpower up to Six Sigma standards. All employees, including top management, should be highly trained, motivated and empowered to be able to fulfil the process and customer requirements. Training is a critical first step. Employees need to know how to change and what to do differently for the Six Sigma programme to happen. This involves the provision of training in quality tools, problem identification and solving skills, in communicating effectively, teamwork and decision making to foster continuous improvement. Ahire *et al.* (1998) emphasised that unless employees have received formal systematic training in quality awareness and quality tools, any sort of involvement will not be effective. In addition, Middle East top management must be well trained and cascade training to their subordinates and this involvement in training will make them obliged to make the trip to quality smooth and successful.

There was clear evidence that employees in these organisations are somehow trained and have good experience but they are not really motivated to be involved in implementing the Six Sigma programme in their organisation. Also, it was clear from the responses given that many organisations had made quite extensive changes to their organisational cultures in order to support Six Sigma implementation. In addition, Six Sigma projects have to be carefully reviewed, planned and selected to maximise the benefits of implementation. The project has to be feasible, organisationally and financially beneficial and customer oriented.

This is a big challenge in Middle East organisations, because most of the employees do not like changes in job style. They may not contribute to such a project and, in the researcher's opinion, the reason is the lack of rotation and team work involvement. If organisations select new employees with two to four years' experience of Six Sigma projects, they may succeed more quickly, because they want to improve and take responsibility in such a project, so employees' resistance would be solved. With a good reward system, they could easily overcome this kind of challenge. It is a challenge to change employee culture because most employees cannot accept any changes. The other reason is that some employees worked in one place for a long time and the job process has become part of their daily routine, so they cannot easily accept the change.

The implementation of Six Sigma methodology needs to fit with an organisation's culture. It seems that most of the responding organisations which have succeeded in managing change have identified that the best way to tackle resistance to change is through increased and sustained communication, motivation and education.

There were some difficulties in obtaining data, including the lack of any survey activities by most of the organisations, lack of research and development units and the lack of other external institutes to conduct such activities. There is no kind of information sharing between Middle East organisations, which makes benchmarking against competitors or best practice in the country not visible. It is essential that besides the communication process one should also take care of overcoming the barriers which can affect it. Without effective communication, there can be little or no organisational performance and innovation.

Six Sigma requires top management dedication and contribution to resources and effort. They should be influential enough to restructure the business and change the attitudes of the employees towards Six Sigma. The Middle East organisations' CEOs are often involved in the implementation of Six Sigma. Organisational infrastructure needs to be established with well trained individuals ready for action. Implementation of Six Sigma projects means commitment of resources, time, money and effort from the entire organisation.

From the interviews with Middle East interviewees, there was evidence of good communications between the top management and low level employees, which is a vital step to introduce quality management to the organisation through employee involvement. Communication is the first step to open channels of understanding between management and employees and to build trust and respect which is the case now in some Middle East organisations, as one of the interviewees stated. All respondents agreed that there has to be open door communication between the lower employee levels and top management in the organisation; projects have to include telling employees about objectives or benefits. Most of the Middle East organisations have multi-national employees with different languages and different religions. These factors affect the communication process among themselves and their relationship with their top management.

There has to be a clear set of measures and metrics to incorporate customer requirements. The project has to be reviewed periodically to evaluate the status of the project as well as the performance of the Six Sigma tools and techniques being implemented. The project should be well documented to track project constraints, mainly cost, schedule and scope. There should also be a 'lessons learned' mechanism to capture the key issues of previous projects.

Overall, interviewees noted the importance of ensuring the integration of Six Sigma with customer satisfaction in order to be successful in the Middle East context. The interviewees also gave specific examples of the types of measures introduced by an educational establishment to support Six Sigma implementation. In addition, they provided a number of examples of specific organisations which had successful Six Sigma implementation and which largely mirrored those mentioned by the other interviewees as being used to support Six Sigma in other Middle East countries. These included, for example, extensive Six Sigma training programmes, reorganisation of employees into teams, customer satisfaction and changes to a Six Sigma culture.

The majority of interviewees indicated that the Middle East organisations are now promoting Six Sigma as a way of increasing efficiency and productivity in all sectors. Continuous Improvement (CI) means making things better. It refers to all efforts directed to increase effectiveness and efficiency in meeting accepted customer expectations. It involves analysing and redesigning processes to remove barriers and inefficiencies in the organisation.

The major conclusion reached in this study, supported by the findings, is that all 19 CSFs are essential for a successful implementation of Six Sigma and ensuring an organisation-wide commitment to that. The interviewees stressed the importance of all the 19 CSFs and to involve them in the Six Sigma initiative in order for it to be successful. Some of the interviewees commented that organisational culture in their organisations was traditionally somewhat bureaucratic and inefficient and that when introducing Six Sigma there had been a need for organisations to review and improve their processes. It was noted that Six Sigma had become a popular management method which supports process change and focuses on continual improvement of working practices. Process improvement also brought about a need for training employees in methods of measuring outputs and quality.

In the conclusions that can be drawn from the study findings, it might be inferred that organisations in the Middle East are making considerable efforts to adapt their working cultures to support effective Six Sigma implementation. In addition, the 19 CSFs identified play a significant role in the Six Sigma project implementation in the Middle East and respondents and interviewees share the same perceptions concerning the criticality of the 19 CSFs. The impact of these factors affects successful and effective Six Sigma implementation. They must be carefully considered and monitored at all stages of the Six Sigma project implementation in the Middle East.

8.3.4 Key Findings on Satisfaction with Six Sigma Implementation

Another main objective of this study was to explore the level of satisfaction with Six Sigma implementation in the Middle East organisations (Section 1.4).

The findings of the qualitative data analysis of the interviews supported the findings gained from the quantitative data analysis (Sections 6.3.4 and 7.3.4, and Tables 6.55 and 7.26). Interviewees had a high level of satisfaction with their organisations' implementation of Six Sigma projects for almost all. In addition, most interviewees prefer Six Sigma as being excellent, which is a higher level compared to other quality management initiatives. In addition, the respondents and interviewees felt that the present atmosphere and state of most Middle East organisations are right and mature for successful implementation of Six Sigma.

Regarding whether there is a difference in the satisfaction with the Six Sigma implementation programme, the results of the significant differences' analysis clearly revealed that (see Section 6.3.4.2):

- There were slight differences ($P < 0.05$) in the satisfaction with success of Six Sigma implementation between the three countries (see Table 6.54). UAE organisations were more satisfied than their Egyptian and Saudi counterparts.
- There were slight differences in satisfaction ($P < 0.05$) between the sectors (manufacturing and services) (see Table 6.55). Services organisations were more satisfied than their manufacturing counterparts.
- There were no differences in satisfaction ($P > 0.05$) between the size of organisations (large organisations and SMEs) (see Table 6.56). This indicates that both large organisations and SMEs respondents are equally satisfied with their implementation of Six Sigma.
- There were no differences ($P > 0.05$) in satisfaction with the success of Six Sigma implementation between the managerial and operational organisational positions (see Table 6.57). This indicates that respondents in both organisational positions are equally satisfied with their implementation of Six Sigma.

The results of the correlation indicate that:

- CSFs of Six Sigma project implementation are highly correlated with the satisfaction with success of the Six Sigma project (see Table 6.61). Therefore these variables are considered as very significant for the successful and effective implementation of the Six Sigma model.
- There is a significant relationship between all the CSFs and satisfaction. This means that an increase in the CSFs' considerations leads to an increase in satisfaction.

Therefore we can conclude that, generally, all the respondents, interviewees and their organisations were highly satisfied with the results of their current implementation of Six Sigma projects, regardless of countries, sectors, organisation sizes and organisational positions. The level of satisfaction in the three countries was slightly different, respondents and interviewees in UAE organisations being more satisfied with implementation than their Egyptian and Saudi counterparts. Furthermore, the services sector organisations were more satisfied with their implementation than their counterparts in manufacturing. In addition, the level of satisfaction in the two sizes of organisations was almost the same. Finally, in the organisational positions, the level of satisfaction in both was almost the same.

8.4 Proposed Generic Model for Successful and Effective Implementation of Six Sigma in Middle East Organisations

Finally, as stated in Section 1.4, one of the main objectives of this research is to propose a generic model for successful and effective implementation of Six Sigma in Middle East organisations. Accordingly, this is based on the comprehensive review of literature, best practices and comprehensive discussion and interpretation of overall findings derived from the analysis of data of this study that highlighted the elements found to be critical to Six Sigma implementation identified through the survey questionnaire and interview findings. It is thus appropriate and beneficial to combine the elements into a generic model that can provide a description of their role in successful implementation. Figure 8.2 illustrates the proposed model.

As the figure shows, the proposed model has been divided into five elements representing dimensions related to successful and effective implementation of Six

Sigma. All the elements are interdependent and each dimension has to be well managed and should be used to drive the next dimension. In other words, failure in one element can have a ripple effect; therefore each element must be carefully considered and all addressed at the same time to ensure successful implementation.

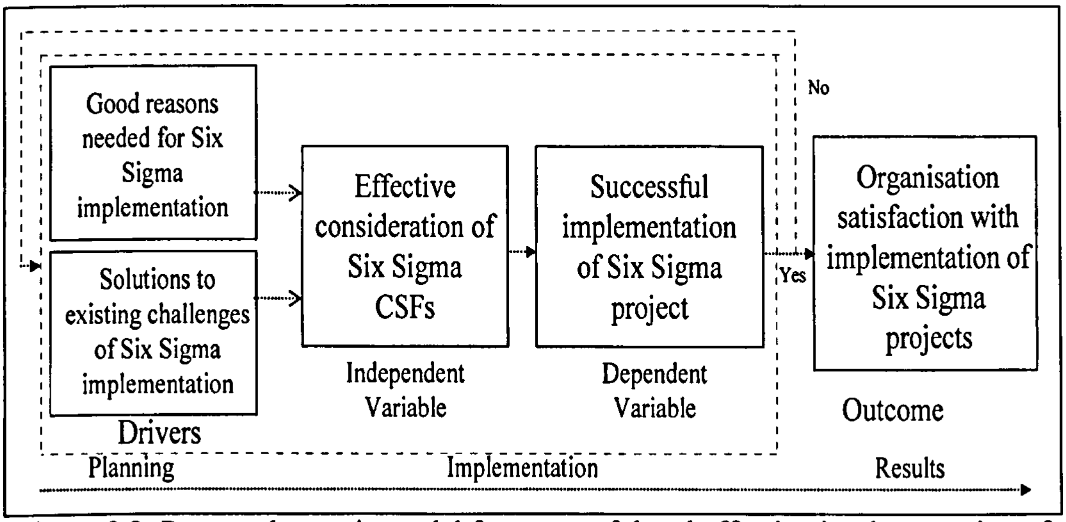


Figure 8.2: Proposed generic model for successful and effective implementation of Six Sigma in Middle East organisations

The correlations among these sets of elements were tested and indicated a highly positive correlation between (1) good reason needed for Six Sigma implementation and effective consideration of Six Sigma implementation, (2) proper solutions to existing challenges of Six Sigma implementation and effective consideration of Six Sigma implementation, and (3) effective consideration of Six Sigma implementation and successful implementation (see Section 6.3.4.2.2, Table 6.60). The results show evidence of a strong positive correlation between all variables and should be considered as a significant factor in implementing Six Sigma. The model shows a very significant correlation as well as a strong support for the correlation analysis between the variables. These variables proved to be high and provide evidence that the research model is conceptually and empirically valid.

Primarily, it is vital to note that the fundamental structure of the proposed model is based on two main claims. First, there is an internal correlation between the elements; second, there is a good and direct influence of CSFs on organisations' satisfaction with the successful implementation of Six Sigma. So, the fundamental premise of the model is that Six Sigma will lead to superior results of successful implementation that lead in turn to high satisfaction. Furthermore, the model is a guide for any organisation thinking about or already implementing a Six Sigma project. The model allows the organisation to focus on all the elements required to make the project a success and helps to avoid any pitfalls.

The model represents a highly useful key to establishing Six Sigma success in the Middle East and for increasing the degree of effectiveness in the implementation of Six Sigma by other Middle East organisations. It reflects the study findings and has been conceived and structured for maximum practical value in providing useful implementation guidelines and in serving as a good theoretical and empirical model for improving Six Sigma implementation within the Middle East organisations. Furthermore, the model can be generalised in the Middle East, applied to organisations of any size or sector and, as well, be used in a generic sense by Middle East organisations with different geographical locations and industry backgrounds.

The researcher can strongly conclude that the proposed model can be applied to all organisations implementing Six Sigma in the Middle East (large organisations and SMEs, manufacturing and services).

8.5 Chapter Summary

This chapter has provided a comprehensive discussion of the empirical findings of the study obtained from results of analysis of the research survey questionnaire (quantitative analysis) and semi-structured interview (qualitative analysis), Chapters 6 and 7, respectively. These findings were discussed, summarised, reviewed and validated in terms of the review of literature. The discussion of the general findings of the research demographic data and of the major findings of the research questions is presented in detail. Furthermore, the results of the survey are discussed in conjunction with the conclusions reached from the semi-structured interviews, which are also summarised in this chapter. Finally, from the key findings, according to systematic analysis and integration of data from the quantitative and qualitative research, an implementation model for effective implementation of Six Sigma has been proposed. The proposed Model provides guidelines on how to create a successful and effective Six Sigma implementation as the target of the quality process.

A comparison was made between characteristics of the three countries, the two industry sectors, the two organisation sizes and the two organisational positions. The findings were then discussed by comparing with the literature review.

The following chapter will present the final and overall conclusions and recommendations drawn from the study.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

This final chapter presents the conclusions and recommendations of the thesis and reviews and summarises the whole of the present research. First, it overviews the research questions, aim and objectives, the design and methodology, data collection and data analyses and then a summary of the findings (Section 9.2). Next, it gives overall conclusions based on the analysis and the findings of the quantitative and qualitative analysis of the study (Section 9.3). In addition, it provides the contributions of this research, divided into literature, methodological and practical (Section 9.4). Fourth, it highlights limitations of the research (Section 9.5). Fifth, it gives recommendations based on the research findings (Section 9.6). Then it offers suggestions and directions for future research (Section 9.7) and summarises the chapter (Section 9.8). Finally, it ends with some concluding remarks (Section 9.9). The structure of this chapter is shown in Figure 9.1.

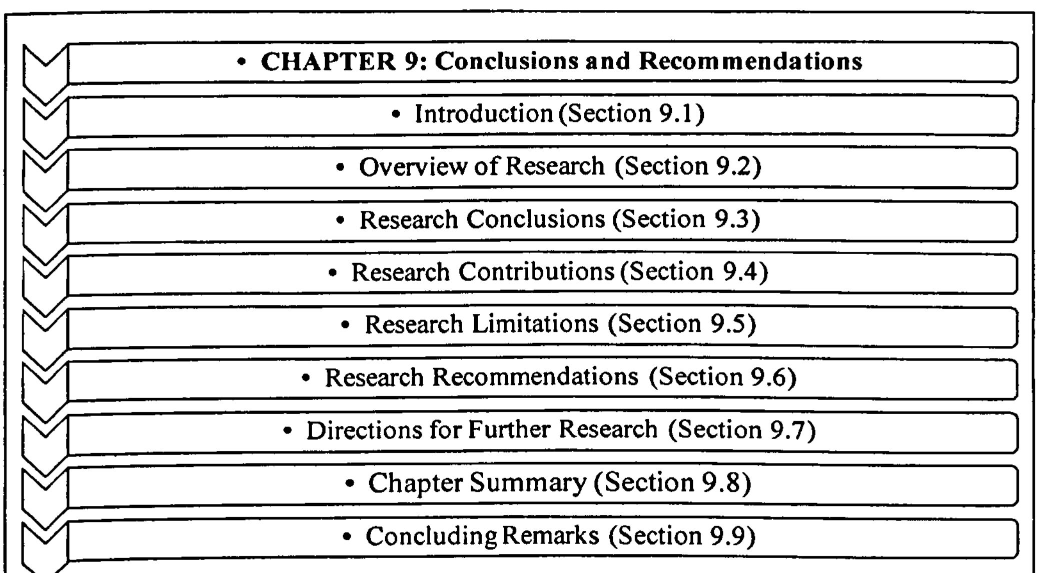


Figure 9.1: Structure of Chapter 9

9.2 Overview of Research

By recognising the gaps in current literature, this study was able to identify relevant dimensions of Six Sigma implementation and the related literature concerning the fundamentals of Six Sigma was reviewed in Chapter 2. Subsequently, Chapter 3 discussed in brief the implementation issues of Six Sigma. Then, critical factors for successful and effective implementation of Six Sigma in Chapter 4. The research design and methodology were presented in Chapter 5 and the quantitative and qualitative data were analysed in Chapters 6 and 7, respectively. The interpretation and discussion of quantitative and qualitative results and proposed model were then addressed in Chapter 8. The following sub-sections now provide an overview of the research questions, aims and objectives, an overview of the research design and methodology, data collection and data analyses and then a summary of the key findings and generalisation of research findings.

9.2.1 Overview of Research Questions, Aim and Objectives

To deal with the research problem gaps, the following was the main research question answered:

RQ: How far are the Middle East organisations from being Six Sigma ones?

Besides this main question, the following six research sub-questions were also answered in the sections indicated, as follows.

RQ1: What is the current status of Six Sigma implementation in the Middle East context? (Sections 6.2.1, 6.2.2, 6.2.3, 6.2.4, 7.2.1, 7.2.2, 7.2.3, 7.2.4, 8.2.1, 8.2.2, 8.2.3 and 8.2.4).

RQ2: What are the reasons/benefits that encourage organisations to implement Six Sigma projects in the Middle East context? (Sections 6.3.1, 7.3.1 and 8.3.1).

RQ3: What are the major challenges that might be commonly encountered during implementation of Six Sigma projects in Middle East organisations? (Sections 6.3.2, 7.3.2 and 8.3.2).

RQ4: What are the critical success factors (CSFs) for the implementation of Six Sigma in the Middle East context? (Sections 6.3.3, 7.3.3 and 8.3.3).

RQ5: What is the level of organisations' satisfaction with their implementation of Six Sigma projects in the Middle East context? (Sections 6.3.4, 7.3.4 and 8.3.4).

RQ6: How could Six Sigma projects be implemented successfully and effectively in the Middle East organisations? (Section 8.4).

As mentioned previously (Chapter 1), the aim of this empirical research is exploratory and comparative in nature and related to the main research question of how far the Middle East organisations are from being Six Sigma ones. It therefore seeks to answer the research questions and contribute to the body of knowledge in the Six Sigma field by exploring and gaining a richer picture of the current status of the implementation of Six Sigma in Middle East organisations and to identify a comprehensive set of potential determinants influencing the successful implementation of a Six Sigma project. To achieve this effectively, the nine research objectives were carefully thought out to answer the six sub-questions and each objective was discussed and addressed separately by means of a triangulation method (questionnaire and interview) as follows:

1. To answer RQ1:

- RO1: To give a clear profile of the organisations that have implemented or are implementing Six Sigma projects (Sections 6.2.1 7.2.1 and 8.2.1) by determining the organisations' locality (Saudi Arabia, Egypt or UAE) (Sections 6.2.1.2, 7.2.1.2 and 8.2.1), sector (manufacturing or services) (Sections 6.2.1.3, 7.2.1.3 and 8.2.1) and size - according to number of employees (large organisation or SME) (Sections 6.2.1.4, 7.2.1.4 and 8.2.1).

- RO2: To give a clear profile of the personnel responsible for Six Sigma implementation (Sections 6.2.2, 7.2.2 and 8.2.2) by determining their nationalities (national or non-national) (Sections 6.2.2.2, 7.2.2.2 and 8.2.2), their organisational positions (managerial or operational) (Sections 6.2.2.3, 7.2.2.3 and 8.2.2), their Six Sigma roles (top management, Champion, MBB, BB, GB) (Sections 6.2.2.4, 7.2.2.4 and 8.2.2), time spent in the organisations (Sections 6.2.2.5, 7.2.2.5 and 8.2.2), time as Six Sigma certified/qualified or familiar with it (Sections 6.2.2.6, 7.2.2.6 and 8.2.2) and number of involvements in Six Sigma projects (Sections 6.2.2.7, 7.2.2.7 and 8.2.2).

- RO3: To give a clear profile of the Six Sigma programme (Sections 6.2.3, 7.2.3 and 8.2.3) by determining when it was initiated (Sections 6.2.3.1, 7.2.3.1 and 8.2.3), who was its primary responsible (Sections 6.2.3.2, 7.2.3.2 and 8.2.3) and what other quality initiatives had been implemented or were being implemented at the time of initiation of the programme (Sections 6.2.3.2, 7.2.3.2, and 8.2.3).

- RO4: To give a clear profile of the Six Sigma implementation (Sections 6.2.4, 7.2.4 and 8.2.4) by determining the present status of implementation (Sections 6.2.4.1, 7.2.4.1 and 8.2.4), current pre-DMAIC and DMAIC stages of implementation (Sections 6.2.4.2, 7.2.4.2 and 8.2.4), how many projects had been implemented so far in each organisation (Sections 6.2.4.3, 7.2.4.3 and 8.2.4), the completion time in months of projects implemented (Sections 6.2.4.4, 7.2.4.4 and 8.2.4), the percentage of employees involved in implementation (Sections 6.2.4.5, 7.2.4.5 and 8.2.4), the level of organisational resistance to the programme (Sections 6.2.4.6, 7.2.4.6 and 8.2.4) and the importance of the use of external consultants in the planning and implementation of Six Sigma in the organisations (Sections 6.2.4.7, 7.2.4.7, and 8.2.4).

2. *To answer RQ2:*
   - RO5: To determine the reasons/benefits that encourage organisations to implement Six Sigma projects in the Middle East (Sections 6.3.1, 7.3.1 and 8.3.1).

3. *To answer RQ3:*
   - RO6: To determine and highlight the major challenges (difficulties and barriers) commonly encountered during the implementation of Six Sigma projects in the Middle East organisations (Sections 6.3.2, 7.3.2 and 8.3.2).

4. *To answer RQ4:*
   - RO7: To identify the CSFs that impact on the effective implementation of Six Sigma in Middle East organisations (Sections 6.3.3, 7.3.3 and 8.3.3).

5. *To answer RQ5:*
   - RO8: To measure the organisations' level of satisfaction with implementation of Six Sigma in the Middle East context (Sections 6.3.4, 7.3.4 and 8.3.4).

6. *To answer RQ6:*
   - RO9: To learn from best practices and to develop and propose a generic model for successful and effective implementation of Six Sigma in the Middle East

(Sections 8.4). In addition, to make some recommendations to Middle East organisations for successful and effective Six Sigma implementation that include good reasons and full benefits from implementation, solutions to existing challenges of implementation and recommendations for effective consideration of CSFs of Six Sigma.

9.2.2 Overview of Research Design and Methodology, Data Collection and Data Analysis

To obtain a deeper understanding of the current status of the implementation of Six Sigma in Middle East organisations, a systematic study with a review of the relevant literature was undertaken, followed by extensive data collection, analysis and interpretation. Consequently, the researcher was very careful when choosing data collection methods to ensure the data generated fit with the research objectives and answered the research questions.

As mentioned in Chapter 5, to achieve the study objectives, this research was empirically deductive, exploratory and comparative, using a methodological triangulation approach combining quantitative (questionnaire) and qualitative (semi-structured interview) methods. A questionnaire and interview were used as confirmatory tools to answer the research questions and are viewed as complementary to each other. The overall aim of using mixed methods was to make ensure the research findings (the questionnaire findings and the semi-structured interviews findings) are more reliable and valid, and to reduce the level of inherent bias by comparing sets of data, i. e. 'data triangulation'.

A total of 561 survey questionnaires were distributed by hand and e-mail to most, if not all, persons involved in Six Sigma project implementation in 44 Middle East organisations in the three most important countries in the Middle East (Saudi Arabia, Egypt and UAE) that had already implemented or were in the process of implementing Six Sigma projects. The response rate was 41.35 % (232 questionnaires), considered very satisfactory, and it could be said that the actual response rate was very high for this type of research. All the responding organisations have experience of Six Sigma but with varying levels of progress and success. In addition, 74 semi-structured interviews took place with respondents at different levels of Six Sigma knowledge and expertise, representing 37 Middle East organisations, following the completion of the survey questionnaire. These interviews provided the researcher with excellent and useful information and their analysis supported the results gained from the questionnaire analysis to explain all the research. A non-probability sampling design (purposive, also called judgement sampling) was adopted. The data were gathered in 2008-2009 and after a pilot study which also tested the validity of the questions designed for the interviews.

The units of analysis (the target respondents for the sampling) were the Six Sigma organisations' senior top management persons such as CEO, MD, general managers and quality managers and Six Sigma certified/qualified persons (Champions, MBBs, BBs, GBs) as being directly involved in the implementation process and having knowledge and experience of Six Sigma projects in their organisations.

The collected data were analysed using *SPSS* (Statistical Package for Social Sciences) (version 16) and Microsoft Excel 2007. An identical methodology was applied to each key issue of Six Sigma implementation in this research. For each of them, the descriptive analysis highlighted measures of mean and standard deviation, and then results were ranked to prioritise the items for each of the three countries, then overall. The same statistical analyses were applied. The statistical test procedures to determine the degree of significance and correlation between the issues were also presented. Similarities and differences between the experience of Six Sigma implementation for Saudi Arabia, Egypt and UAE and then overall were considered and analysed.

Reliability analysis was carried out for all the measuring instruments in the questionnaire by computing the correlations of each item's score with the total scale score (corrected item-total correlation) and also a coefficient alpha to obtain the total dimension of the constructs; Cronbach's alphas were also used to assess the internal consistency reliability. The results for testing question reliability indicated that the questions were reliable. Moreover, the correlations between the research variables were calculated. Data analysis was done by compiling the data and presenting the findings in graphs, charts and tables, which were then discussed by comparing with the literature review. In addition, comparative analysis of data from respondents of the three countries was tabulated to present differences and similarities of their implementation. The results were then benchmarked against the cultural contexts of the three countries.

In addition, the proposed research model and the relationship among the variables in this research were examined using correlation coefficient analysis and the coefficients were used to validate the model. The test probed the relationships between each of the independent and dependent variables in the model and revealed a correlation between them. Relationships between dependent and independent measures were analysed with correlation techniques. All these tests were done with a confidence level of 95% and 2-tailed significance results. Measures of correlation indicate the strength and the direction of the linear relationship between a pair of variables. In addition, it is important to assess the significance of the relationships, of which only the significant ones can be accepted and all the results of the correlation analysis are presented and discussed.

9.2.3 Summary of Key Findings

To summarise the key significant findings, the study revealed that:

- Generally, Six Sigma is still in the beginning stages of the implementation approach in the Middle East organisations.
- All the responding Middle East organisations have experience of Six Sigma but with varying levels of progress and success. The selected sample varied in location, business sector, size and maturity level of its implementation.
- Six Sigma has been implemented in both manufacturing and services organisations in the three countries covered. Overall, the majority were in the services sector.
- Six Sigma has been implemented in both sizes of organisations: in large organisations and in SMEs in the three Middle East countries, more by the former than the latter.
- Overall, the nationality percentages of questionnaire respondents were the same, with 50% nationals and non-nationals, while the interviewees were 55.41% and 44.59%, respectively.

- Six Sigma has been implemented by both organisational positions: managerial and operational. Overall, the majority of the respondents and interviewees were managerial rather than operational in all three countries.
- The Six Sigma roles of the respondents and interviewees were mainly top management executive managers (CEOs, general managers), quality managers, Six Sigma Champions, MBBs, BBs and GBs. Overall, the majority of respondents and interviewees were BBs.
- Overall, the respondents and interviewees have been working in their organisations for different lengths of time, the majority for around 10 years.
- Overall, the respondents and interviewees were certified/qualified and familiar with Six Sigma implementation. The majority had between 6 and 8 years' experience.
- For involvement of respondents and interviewees in Six Sigma implementation projects, overall, the majority were involved in between 1 and 10 projects.
- The majority of the organisations have been implementing a Six Sigma programme for about 7 years.
- In most cases, Six Sigma was responsible by external consultants, followed by directors.
- All the responding organisations had implemented one or more of the other quality programmes (TQM, ISO-9000, BPR or Benchmarking) before embarking on the Six Sigma programme to measure their process performance and reach customer satisfaction.
- Regarding the implementation status of Six Sigma, most of the organisations are in the partially (DMAIC) stage of Six Sigma implementation.
- For the current pre-DMAIC and DMAIC stages of Six Sigma implementation, overall, in the pre-DMAIC stage, the respondents' and interviewees' organisations were in the training and start-up stages. In addition, in the DMAIC stages, most of the organisations were in the analyse stage.
- Regarding the number of projects completed, overall, most of the organisations had completed 6-10 projects, followed by 11-15. No organisation so far had completed more than 40 projects.
- Regarding the average time for completing implementation of Six Sigma projects, most of the respondents and interviewees reported an average of 4-6 months and 7-9 months, respectively.

- The majority of organisations involved around 1-20% of their employees in the Six Sigma projects.
- Regarding the organisational resistance to Six Sigma implementation, overall, most of the organisations had not faced any resistance.
- Overall, the majority of respondents and interviewees see the use of external consultants to assist them in implementing Six Sigma as very important.
- All the Middle East organisations used external consultants, mostly for training Six Sigma team members, to facilitate the implementation of Six Sigma.
- Regarding the potential benefits achieved through Six Sigma implementation, the results showed the most significant benefits achieved.
- The most significant reasons for/ benefits of Six Sigma implementation in the Middle East gained include improving customer satisfaction (understanding customer needs and expectations), improving business, financial performance and organisation efficiency, building organisation reputation and creating new customer opportunities, improving process performance continuously from reactive to proactive and improving and increasing earnings, profitability and market share.
- Regarding the challenges faced in Six Sigma implementation, the study indicated the major challenges faced by the organisations in the Middle East, which include lack of top management commitment and support, lack of communication, selecting suitable projects, organisational resistance (fear of change) and insufficient training.
- The most significant CSFs of Six Sigma in the Middle East include top management commitment and support, continuous training and education, readiness for cultural change, integrating Six Sigma with customer satisfaction, with corporate business strategy, and with existing initiatives, and project management skills.
- Most of the organisations are satisfied with the results of implementation of Six Sigma.
- In the end, based on overall findings of the study, a proposed generic model for successful and effective Six Sigma implementation in the Middle East has been developed.

9.3 Research Conclusions

In the light of the research findings from the two methods and their discussions, many conclusions can be drawn from the study which had the aim of investigating the current status of Six Sigma implementation in the Middle East.

Generally, the research results reveal a number of inspiring, interesting and significant findings. Further, this study provided clear evidence that Six Sigma is being implemented and has been growing in the Middle East organisations. More and more of them of different sizes and from different sectors are beginning to implement Six Sigma projects. Successful implementation and growing organisational interest in Six Sigma programmes have been exploding in the last few years in the Middle East. It is rapidly becoming a major driving force for many organisations.

The study results gave a sufficiently and fairly representative and complete picture of the nature and current status of implementation in the organisations studied. It presented the current status of Six Sigma implementation in the Middle East by identifying and presenting the most reasons for/ benefits of implementation of Six Sigma, the most common challenges faced and the CSFs of successful and effective implementation and, finally, the level of satisfaction with the implementation. Understanding the key features, reasons/benefits, challenges and CSFs of Six Sigma provides opportunities to practitioners for better implementation of Six Sigma projects.

This study has given a broader picture of the similarities and differences between the experiences of Six Sigma implementation in three Middle East countries. Also, the study reveals there are no obvious differences in findings between the three Middle East countries, sectors or size of organisation on implementation in the Middle East, implementation strategies or results achieved. In addition, the study provided useful insights and indications as to how Six Sigma is implemented in the Middle East. The comparison between the three countries sheds light on the influence of culture in Six Sigma implementation. While the original focus of Six Sigma was on manufacturing, today it has been widely accepted in the Middle East in both manufacturing and services processes.

Six Sigma implementation in the Middle East organisations aims to eliminate defects and the opportunity for defects. It uses a statistical unit of measurement to measure the capability of the process, then achieve defect-free performance and ultimately increase the bottom-line and customer satisfaction. It provides a better product or service faster and at a lower cost than the competition and it helps organisations to focus on developing and delivering near perfect products and services. Six Sigma is a management philosophy that can radically change the way mistakes are treated in the workplace. It is focused on eliminating these mistakes, thus teaching personnel how to improve the conduct of business in the process. Six Sigma is a philosophy, a methodology and a process that incorporates change within an organisation to bring about improved business results and customer satisfaction. Six Sigma places an emphasis on data-driven, root-cause analysis by using a diverse collection of tools to identify and address the sources of special and common cause variation within the process.

Currently, it can be argued that, although the Six Sigma programme is still relatively new within the Middle East countries, it is well established, it is the fastest growing business management system in Middle East industry today and is spreading at a greater speed there as its implementation becomes more successful. It is also increasing in strength as it is used systematically and has quietly penetrated into the culture and has helped the Middle East organisations to produce products and services better, faster and cheaper by improving the capability of processes to meet customer requirements. The researcher believes that Six Sigma is implemented in the correct way in the Middle East and organisations derived greater benefits and its maximum potential.

Six Sigma initiative in the Middle East aims to increase the effectiveness and efficiency of processes to meet customer expectations. This requires better understanding of the customer's requirements and expectations (internal and external). For Six Sigma implementation in the Middle East to be successful, every member of the organisations should have a clear understanding of customer requirements. The Six Sigma journey should start with an organisation belief and commitment to the philosophy of Six Sigma by the top management. It requires significant changes in management philosophy and behaviours; it requires new priorities, additional resources, energy, time and consistent support. Six Sigma quality improvement is a continuous process and should not be thought of as something with a beginning and an end. Without a strong commitment from the top to develop a healthy culture, based on fairness, respect, trust, open communication, shared information and teamwork, most organisations will not get very far in Six Sigma.

Cultural changes require time and commitment before they are strongly implemented into the organisation. Effective Six Sigma principles and practices are more likely to succeed by refining the organisational culture continuously. It must highlight that the creation of a Six Sigma culture is neither fast nor easy. It takes a long time to achieve transformation. But it depends on the degree of current efficiency and effectiveness in the organisation and of course on the high degree of commitment of top management and employees alike.

Generally, although Six Sigma is a relatively new experience in the Middle East, the study findings have pointed out that successful Six Sigma implementation is complex and does not come without challenges and those were analysed. It has, generally, been successfully implemented and its tangible and intangible benefits are obtained and acknowledged and it is being used extensively in all their industries. An improvement culture is developed and promoted throughout the organisations. In addition, currently, Six Sigma in the Middle East context is the most effective concept because of the interrelation between its strategy, organisational structures, procedures, tools and methods.

Six Sigma has given Middle East organisations a new way of doing business, enabling them to make a wise application of statistical tools within a structured methodology, and repeat application of strategy to individual projects, and complete projects that have had a substantial impact on the 'bottom line' (profit) as well as the 'top line' (revenue). The successful implementation of Six Sigma in the Middle East can be seen as a reaction to increasing productivity and competitiveness in the region.

To overcome the challenges, the organisation needs a structured approach to assessing the status of the organisation, preparing the organisation at all levels in all ways, selecting and training personnel, ensuring well-rounded skills in all analysts, listening to feedback in an unbiased way and using structured measurement methods to assess if the method is truly adding the desired benefits to the business.

Middle East organisations should be basically healthy before beginning Six Sigma implementation. Challenges within the Middle East organisations seem to be not difficult to overcome. The key to successful change is to believe that culture change is needed and it could happen as it has happened before in other quality management systems. For this to occur, a rigorous plan is needed to eliminate these challenges and prepare the ground by educating the top management who can take up the challenge and lead the transformation of the Middle East organisations through the full involvement of every employee by empowering them to take the responsibility for improving their organisations.

This study has highlighted a number of elements found to be critical in implementing Six Sigma in the Middle East. It has identified a series of CSFs (19) that must be carefully considered to ensure successful and effective Six Sigma implementation in the Middle East and that have a direct impact on successful implementation of the Six Sigma, all of which are highly interdependent. Nevertheless, it is crucial to address all these CSFs at the same time for successful implementation. In essence, failure in one factor can affect the overall Six Sigma project implementation.

It must be highlighted that the success of Six Sigma in the Middle East depends highly on establishment of the right organisational structure and culture in addition to the technical aspects of the implementation strategy. Fundamental improvements can be made only when the organisational culture is committed to change and everyone within the organisation is truly willing to make improvements in the way they do business. Through effective organisation-wide communication, organisational structure, appropriate reward and recognition systems and training policy, Six Sigma helps in creating the organisational culture, top management awareness, commitment and continuous follow-up throughout the programme which are crucial for successful Six Sigma implementation and creation of an improvement culture.

The research concluded that the most important CSFs results are top management support and creating an effective organisational culture change. Most of the responding organisations do have support from top management but the question is 'Is this support proper and strong enough to develop the organisation's Six Sigma implementation?' Based on the interviews, it is clear that most of the organisations feel good towards the top management because they get appropriate support. Also, because the Six Sigma concept is mature and new management, the top managements are certified/qualified to understand the new approach. Without continued top management support and enthusiasm, implementation will not be a success and most of the organisations feel good towards the top management because they get appropriate support. Middle East organisations saw the strong support of the CEO as being the key factor for the effective introduction and implementation of Six Sigma.

Top management of the Middle East organisations have serious commitment in the form of time, effort and resources. Culture change is essential to prepare an organisation to achieve successful Six Sigma implementation. An effective change of culture ensures a smooth implementation of Six Sigma with minimum resistance. Six Sigma is not only a statistical or technical component, it is a cultural component. Also, effective communication, teamwork, and employee education and training are considered as further important factors for Six Sigma implementation.

Considering cultural changes, most respondents and interviewees representing responding organisations indicated the importance of organisation-wide cultural acceptance of change prior to their implementation of Six Sigma. Six Sigma involves cultural change at all levels of an organisation since efforts to adopt Six Sigma would succeed only if they are accompanied by cultural change. It seems that some organisations that have succeeded in managing change have identified that the best way to tackle resistance to change is through increased and sustained communication, motivation and education. It is important as well to get as much practical feedback as possible from employees, plan the change through detailed Six Sigma implementation milestones, delegate responsibilities when possible and empower people to make their own decisions.

The researcher can conclude that Six Sigma has both management and technical components. The focus of the management component is to select the right people for Six Sigma projects, select the right process metrics, provide resources for Six Sigma training, provide clear direction and guidance with regard to project selection, etc.. The focus of the technical component is on process improvement by reducing variation, creating data which explain process variation, using statistical tools and techniques for problem solving, etc..

9.4 Research Contributions

This study, being within its scope, has contributed to the wealth of literature on Six Sigma implementation. The findings of this research have several important contributions which could be very useful to the Middle East organisations and they will be explained from the perspectives of contributions to the literature and methodological and practical aspects in the following sub-sections.

9.4.1 Contributions to Literature

As clarified earlier (Section 1.3), extensive reviews of relevant literature reveal that there is no scientifically solid empirical research which has been undertaken and published on Six Sigma implementation in the Middle East in general (to the knowledge of the researcher). The bulk of the literature is based on concepts of Six Sigma, personal experiences and subjective evidence rather than on empirical investigation. So this research is thus offered and has added several distinctive contributions to the literature of Six Sigma field by filling gaps in the existing literature with several dimensions to the investigation of implementation of Six Sigma in the Middle East.

So, the most important contribution of this study is its uniqueness and originality as the first of its kind to assess and examine empirically and comprehensively the current status of Six Sigma implementation in the Middle East. In particular, the study has been uniquely effective in understanding, identifying and describing Six Sigma in the Middle East. It has empirically highlighted and identified a series of vital issues that must be carefully considered to ensure successful Six Sigma implementation never done before in the Middle East such as the reasons/benefits for implementing Six Sigma, the challenges facing the implementation of Six Sigma in Middle East organisations and the key CSFs for the effective implementation of Six Sigma programmes in Middle East industry distilled from a comprehensive review of Six Sigma concepts and practice never carried out before in the Middle East.

9.4.2 Methodological Contributions

This study has developed a sound and solid method to test empirically multi-country samples. It also provided contextual and situational insights into how the organisations from different country backgrounds have implemented and dealt with Six Sigma. The evidence and factors emerging from these experiences have provided useful insight into the importance of different factors and variables. Therefore, using both techniques led to a richer understanding of the phenomena under investigation. In this respect, this study can serve as an exemplar of how quantitative and qualitative studies can be used jointly.

9.4.3 Practical Contributions

This research has provided several major practical contributions by providing useful guidelines and significant resource for both academic researchers and practitioners in the Middle East to conduct further study in this field in the Middle East, to encourage them to present scientific, practicable and specialist studies in this field, and to understand the core characteristics of Six Sigma quality projects and the appropriate roles they should play during the stages of implementation and the appropriate factors they should consider for effective and successful stages of Six Sigma implementation. Also, it provides a roadmap on how to implement Six Sigma successfully and effectively in the Middle East. In addition, this study has covered the Middle East and many other countries might benefit from the findings of this research for their own organisations. Also, the research is expected to provide useful information and great benefits to organisations implementing or wishing or planning to implement Six Sigma projects. This will also help them to avoid the risks during Six Sigma and the quality culture. It will help them to understand better the implementation of Six Sigma from an integrated point of view.

This study has included a large number of comparisons between the three Middle East industries. These comparisons may help to inform Middle East industries to evaluate their position among other countries and to take the necessary measures to correct any problems in their organisations. It has also been very keen to compare Six Sigma implementation in the Middle East in respect of countries, sectors, sizes and organisational positions, which has been intended to give a new dimension of Six Sigma implementation in the Middle East. It has laid stepping stones for Middle East organisations from which to initiate an implementation of Six Sigma and has highlighted some of the potential pitfalls which may be encountered along the way. Also, it provides and develops a step by step guide towards the successful and effective implementation of Six Sigma in the Middle East and helps to gain greater understanding of Six Sigma implementation in the region. It also offers some prescriptive guidelines for organisations interested in or currently implementing Six Sigma. In addition, the findings of this study are important and relevant to all industry sectors with all sizes of organisations in the Middle East. It has provided useful guidelines in the form of the critical elements and factors that can engender success or otherwise in Six Sigma efforts.

Finally, this study proposed a generic model that can be considered as a guide and checklist for successful and effective implementing of Six Sigma projects in the Middle East. It is expected to be useful to a wide range of organisations, regardless of sector, size, structure or maturity, and for use by organisations to measure the status of their existing Six Sigma practices, to identify shortfalls and gaps and to take steps for improvement, since it provides for a Six Sigma implementation to suit any business situation in the Middle East.

9.5 Research Limitations

No research can be done without some limitations which may constrain the full achievement of its aims and objectives or prevent the researcher from getting all the information wanted. Some of these limitations might be predictable, while others are not. This research is no different; however, every care was taken in structuring the research so that these limitations would not significantly affect its contributions. These limitations, although not impacting significantly on the contributions as outlined in the previous section, are nevertheless important for a more complete understanding of the research. They are mainly related to certain constraints imposed or recognised, such as limited literature, time and resources, effort and difficulty in access, fieldwork and analysis, as follows.

9.5.1 Literature

As discussed earlier in the research problems (research gap) (Section 1.3), Six Sigma implementation is an area of research where literature is still inadequate, especially in the Middle East. This pushed for an option to follow an exploratory approach in this study. During the review of literature, it was found that plenty of authors and researchers cover definitions and importance of Six Sigma implementation but only a few cover key issues in its implementation and none in the Middle East organisations; the lack of such relevant literature and data was a disadvantage. This is particularly the case as the research seeks to investigate Six Sigma implementation in the Middle East, a feature which demands broadening the scope of the study in reviewing a large body of relevant literature and collecting a huge set of appropriate data. However, while the researcher has attempted to meet such a requirement by reviewing various bodies of literature and seeking different types of data from both primary and secondary sources, it is not possible to claim that the empirical investigation of this study has come across all issues related to this perspective, at least those issues presented in the literature.

Since no rigorous theoretical or empirical research studies on implementation of Six Sigma in the Middle East had been undertaken until the present, this limited the literature search and the discussions of findings. So, although this study has added to the originality and value of this work, the researcher has not had the benefit of learning from others' mistakes or building on findings of other studies in the Middle East.

9.5.2 Time and Resources

The limitations of time and financial resources represent constraints for all researches and this study was no exception. Time and resources are very important in any empirical study. Those available for this research were quite challenging. Such a large research like this needs more time and resources in order to enable the researcher to achieve its objectives. Since the research was a triangulation in three countries, the time span of the study was thus limited, constraining the scope of the research. In addition, obtaining data from three different countries is highly costly and needs a lot of time and effort. Finally, as initially expected, the work required to achieve this study would take much longer than the rigid time constraints of doctoral research.

9.5.3 Access

Access is very important in this kind of research, and in this study, access to data required was not easy and it was also not possible to gain access to all of the organisations that implemented Six Sigma in the Middle East countries at that time. The researcher therefore believed that limiting the study to three countries would optimise the use of the available resources and capture the study objectives, since more than three would not have been easy to manage nor practical to achieve. Therefore it is quite clear that the work required close involvement and cooperation from the participating organisations. Good connections and access are crucial in a situation like this. So, getting data from 44 organisations in three countries would be very difficult unless access was gained to them, fortunately granted.

Since the researcher is a Saudi working in one of the participating Saudi organisations, he found that personal relationships are very important to get access to targeted organisations and their respondents. The good relationship allowed the researcher to gather more data in a friendly way. On the other hand, the Middle East organisations' culture is power-based, so it is difficult to obtain information; the word 'confidential' is common, even among internal employees. If the researcher does not establish a good personal relationship with the targeted organisations and their management before starting data collection, efforts may be doomed to failure.

9.5.4 Fieldwork

Other limitations for this study are related to its fieldwork. Those encountered by the researcher included:

- Considerable efforts were needed to try to convince some organisations and respondents to take part in this research.
- A cultural problem sometimes occurred. While explaining the research topic to some respondents, immediate disappointing responses were encountered due to unwillingness to participate.
- Some respondents in some organisations hesitated to accept questions without approval from their top management.
- Many interviewees, because of their worry that the tape would be passed to their top management, would not tolerate tape-recording of interviews. This was the reason for reliance on field notes of interviews.
- Most of the top management respondents were far too busy to make themselves available for interview.
- Many of the respondents preferred to fill in questionnaires rather than participate in the interview.

9.5.5 Analysis

Another important limitation of this study relates to an issue common to most researches, that is the truthfulness of the respondents and interviewees when completing the survey questionnaire or answering the interview questions. In addition, there is no way to ensure that the respondents always understand the heart of each question in the way the researcher wants it to be understood. Given these considerations, it is reasonable to conclude that the respondents may have provided answers deviating from reality. However, the researcher cross-checked data across the various levels of investigation to reduce the degree of discrepancies that could creep in. He also used interviews to avoid this problem and support the questionnaire results. Unfortunately, the tape recording of interviews was not accepted by interviewees because of their worry that the tape would be passed to their bosses.

Another important point is that, although all the interviewees were willing to answer all interview questions, most of them were giving short answers without any explanation that helped the researcher to take quotations to support analysis. In addition, the data provided were based on what people said rather than on what they do. Whatever the respondents and interviewees replied cannot be automatically assumed to reflect the truth and interview results can be seen as indicative rather than statistically representative of the population as a whole. It is therefore possible that some of these findings may be biased due to the direct participation of the respondents in the organisation's Six Sigma efforts. The study findings depended on the judgement of the top management and Six Sigma certified/qualified people to measure the Six Sigma implementation status in the Middle East organisations. To a greater or lesser extent, this judgement may be subject to bias.

As a final comment on the study limitations, the researcher would conclude that, in spite of these limitations, the research was successful in achieving its objectives and contributions, as well as the researcher's having to learn to balance his personal and family life as well against the heavy demands of his PhD study.

9.6 Research Recommendations

In the light of the research findings, their discussion, the respondents' and interviewees' comments and the researcher's own experience, the following recommendations are made to Middle East organisations to increase the chances of their implementing Six Sigma successfully and effectively. For those organisations just starting a Six Sigma programme, the recommendations will help them to achieve a successful and effective implementation and for those having already launched the programme and not achieving the progress they were expecting, they will help them to get back on track. The research recommendations are presented as follows:

9.6.1 Recommendations to Middle East organisations for improving their implementation of Six Sigma projects successfully and effectively

1. Acknowledge that the aim of being Six Sigma-classed is not merely a matter of simply reducing costs; it is, in fact, the ability to link the organisation's capabilities with market requirements to enhance the organisation's performance in order to satisfy its customers.

2. Push the responsibilities for Six Sigma to the bottom level of the organisation in all functional areas.
3. Acknowledge that top management must take the organisation on a journey from its current state to a desired future state and deal with all the problems that arise along the journey.
4. Acknowledge that changing culture is neither fast nor easy and it takes a long time to achieve transformation (perhaps more than three years), depending first on the country, then on the personality of employees and thirdly on the current inefficiency and ineffectiveness in the organisation and of course on the high degree of commitment of top management and employees alike.
5. Acknowledge that implementing Six Sigma has to focus on both management and technical components. The focus of Six Sigma in management is to select the right people for Six Sigma projects, select the right process metrics, provide resources for Six Sigma training, provide clear direction and guidance with regard to project selection and so on. The focus of Six Sigma technically is on process improvement by reducing variation, creating data which explain process variation and using statistical tools and techniques for problem solving.
6. Acknowledge that implementing Six Sigma will support its organisation. The implementation process needs to be well structured, continually improve processes in a structured and systematic manner but, most importantly, an innovation and improvement climate/culture must be developed and promoted throughout the organisations to ensure long-term success.
7. Acknowledge that Six Sigma cannot be accomplished overnight and it is not a one-time effort; Six Sigma is, rather, a long-term, continuous commitment to improving quality and performance and to meeting customer and market requirements. Hence, organisations must be willing to show unwavering commitment to these efforts, because the results are almost always not instantaneous. Finally, organisations planning to go forward with Six Sigma implementation should be willing to put in consistent efforts and stable commitment and should carefully examine their readiness for it.
8. Use Six Sigma in all areas of the business to align resources to solve critical business problems and deliver strategic objectives.
9. Clearly establish, prior to Six Sigma implementation, the needs for it and top management must have the desire to change.

10. Learn how to walk before running; thus, at the initial stages, Six Sigma projects must start small and then transform into a full-scale implementation as and when required.
11. Learn how to identify the CSFs of Six Sigma implementation as it is otherwise complex and not easy to handle to understand the benefits and avoid implementation failure.
12. Consider adopting other quality programmes (TQM, BPR and ISO-9000) before implementing Six Sigma as experience with previous quality programmes is a significant factor in the success of Six Sigma. Or extract the essential parts from them and implement them with Six Sigma. Either choice would help to increase the chance of a successful implementation of Six Sigma.
13. Accept that successful implementation of Six Sigma is highly dependent on getting the right knowledge to the right people in the right sequence at the right time.
14. Recognise that a successful start of Six Sigma is not the end of the implementation process, but its continuous success must be ensured by making it last, in other words, sustaining the gain.
15. Recognise that effective communication leads to project success and productivity. In addition, the higher the communication richness, the shorter the task-completion time.
16. Acknowledge that it is essential to understand customer needs before implementing a Six Sigma project and evaluate business strategy according to customer expectations and requirements.
17. Focus on how to start Six Sigma for its successful implementation. First of all, the organisation needs a rationale: why does the organisation need Six Sigma? Next, the organisation needs to clarify its goal: what does it want to accomplish with Six Sigma? Then the organisation needs to clarify its time frame to implement the strategy: when does it expect returns and what is the cost-benefit ratio of the effort?
18. Recognise for successful implementation of Six Sigma, the opportunity, as it exists in the organisation, and then decide on willingness to invest the time, people and effort to realise the desired gains.
19. Note that, for successful implementation of Six Sigma, at the initial stages it may be best to select those projects that will show direct and immediate

financial savings; in this way, achievements and success will be more visible. Furthermore, do not set expectations very high as they may not be met and consequently lead to failure.

20. Recognise that Six Sigma quality programme projects work but success hinges on how seriously an organisation takes its quality improvement efforts, and acknowledge that not all Six Sigma programme projects are equal.
21. Reduce levels of organisational hierarchy, remove procedural barriers to change and make a variety of other changes designed to make it easier to try new things without fear of reprisal for successful implementation of Six Sigma.
22. Acknowledge that Six Sigma may be the most powerful tool available for improving quality, but it is not a solution to every business problem and is no substitute for good strategic thinking and planning.
23. Be aware and accept that successful implementation of Six Sigma is neither easy nor fast. It always involves an enormous amount of money, considerable time, people, rapid change, commitment, a massive training programme, significant resources and effort by the entire organisation, based on clear mandates from top management. Moreover, this is a very important point that should be considered for Six Sigma implementation in the Middle East. Therefore, Six Sigma project implementation requires sufficient resources, including monetary, human and technology.
24. Six Sigma should be viewed as an ongoing process, not a one-time project.
25. Realise that Six Sigma takes time and develops in stages, not all at once. Be patient, but be persistent. It is really important that there be someone high up in the organisation who is committed to and passionate about Six Sigma. This person has to be able to push, pull and persuade people to keep going.

9.6.2 Recommendations to Middle East organisations for choosing good reasons and achieving full benefits from Six Sigma implementation

1. Recognise decision to bring in Six Sigma is just the first step on a long journey. It may fail if the focus is solely on the technical side, without considering the cultural and communication aspects.

2. Implement Six Sigma correctly to obtain its benefits and this must be based on the organisation's strategic plan and specific requirements such as top management commitment, support and continuous involvement.
3. Progress more by knowing exactly what needs to be done to become better.
4. Acknowledge that, to take full advantage of the Six Sigma project, the organisation is required to change its business processes to align them with Six Sigma.
5. Manage and take decisions based on a well-defined approach or on the analysis of collected data rather than on personal opinions.

9.6.3 Recommendations to Middle East organisations for providing solutions to existing challenges of Six Sigma implementation

1. Six Sigma is a strategy that depends, begins and ends with the customers. Therefore, the Middle East organisations have to identify their customers before the selection and implementation of the project.
2. Gain an understanding of the challenges of Six Sigma implementation in order to overcome them in the future.
3. Six Sigma project implementation requires long-term commitment from top management through active interest, support and review and the allocation of appropriate resources. Six Sigma identifies and eliminates costs and unlike simple cost-cutting programmes, it delivers cost cuts whilst retaining or improving value to the customer.
4. Acknowledge that all organisation communication must be structured towards the understanding of and commitment to Six Sigma. Nothing moves beyond strategy without effective communication.
5. Apply extensive training to communicate both the why and the how of Six Sigma as early as possible, and provide the opportunity for people to improve their comfort level through training classes before unleashing the employees into the world of Six Sigma.
6. Carefully examine readiness for implementing Six Sigma, keeping in mind the critical stages where certain practices are more appropriate than others.
7. Ensure that training materials available are improved to be more appropriate for their operations.

8. Help the Six Sigma change of culture requirement, a Six Sigma is essentially a new approach for Middle East organisations, through employees' training and education, by providing employees with the skills they require to adapt to and to lead this change process.
9. Consider the key elements of project management, time, cost and quality. Defining them will provide the team with the scope, aim and resources needed to deliver an improvement in the short term, at the lowest cost and meeting the requirements needed.
10. Provide cross-functional teams in which facilitative leadership guides the team to contribute in reaching the business strategy.
11. Communicate project results to all levels throughout the organisation to get the most from the Six Sigma programme.
12. Take the cultural component into consideration for successful Six Sigma implementation which requires an organisation-wide Six Sigma culture, with awareness and buy-in from all employees in the organisation.
13. Acknowledge that the best way to tackle resistance to change is through increased and sustained communication, motivation and education.
14. Acknowledge that successful Six Sigma implementation requires a full and intentional communication strategy. Regular communication should be delivered throughout the organisation, highlighting the importance and benefits of the Six Sigma project, sharing milestones and informing employees about what happens next. Many Six Sigma strategies fail because the employees cannot see the benefits of sharing knowledge. The Six Sigma champions in this case are responsible for building trust in the employees on how Six Sigma benefits them.
15. Recognise that the success or failure of any Six Sigma project is largely dependent on the degree of commitment from the top executive management.
16. Communicate project results to all levels throughout the organisation for successful implementation of Six Sigma.
17. Middle East top management and employees on all levels have to be confident and empowered to deal with the challenges as a part of ordinary organisation life, so these challenges have to teach them what needs to change. But to implement the projects of Six Sigma successfully in Middle East organisations, the results need to be visible and the objectives must be both strong and creative

to develop breakthrough solutions. Also, the employees need to understand their process features to identify opportunities for improvement.

9.6.4 Recommendations to Middle East organisations for effective consideration of Six Sigma CSFs

1. Acknowledge that the CSFs are essential and interdependent and therefore should be taken into account and all must work together for Six Sigma implementation to succeed. Failure in one factor can affect the overall Six Sigma implementation; this would then make the difference between a successful implementation and a complete waste of effort, time and money. Therefore they must be carefully considered as a part of the success of the Six Sigma implementation.
2. Acknowledge that successful implementation of Six Sigma needs to address all the CSFs of Six Sigma at the same time. It could be argued that all CSFs identified are comprehensive, highly interdependent and in common with any successful Six Sigma implementation process. In essence, failure in one factor can affect the overall Six Sigma project implementation.
3. Learn how to identify the CSFs of Six Sigma implementation to gain the benefits and to avoid implementation failure.
4. Acknowledge that a Six Sigma implementation is complex and not easy to handle if the organisation does not consider all CSFs that contribute directly or indirectly to success of the Six Sigma project implementation.
5. Recognise that top management must act practically and symbolically to establish Six Sigma.
6. Ensure that before committing themselves, top management must thoroughly understand the principles of Six Sigma. They must know how to create a vision and how to inspire people to achieve the fulfilment of the organisation's objectives.
7. Ensure and focus on the total understanding and satisfaction of customers.
8. Acknowledge that training has to be provided for all employees to improve interactive skills, such as communication skills, empowerment and leadership skills.

9. Build new Six Sigma culture by reviewing the organisation's culture and comparing it with the Six Sigma culture to define the gaps which exist; put in place strategies to fill those gaps, and move forwards towards a Six Sigma culture.
10. Acknowledge that project management, communication and team working skills are helpful in implementing a Six Sigma project. Moreover, that a high level of management involvement is important, because their interest, support and experience are essential to success.
11. Drive out fear by the top management's making employees agents of change rather than resisters. It has been successful for the organisations that have adopted it and this success will encourage other organisations to do so.
12. Provide extensive training for Six Sigma in the use of quality tools and statistical measures.
13. Learn that continuous improvement can only be accomplished when top management leaders begin to understand the relationships between the inputs to a process and the output. In today's business environment, where employees are a critical factor, staying competitive requires continually improving quality while reducing costs.
14. Recognise that customer satisfaction is the basis of Six Sigma in all respects which must be tracked and its systematic analysis must be continuous. In addition, recognise that integrating Six Sigma with customer expectations and needs is one of the keys of Six Sigma which should begin and end with customers.
15. Acknowledge that Six Sigma is a strategy that depends, begins and ends with the individual customer. Therefore, identify customers before selection and implementation of the project. Accept that the Six Sigma concept should start and finish with the customers, so customer satisfaction is an important issue.
16. Provide necessary skills such as leadership, project management, communication, analytical thinking, good functional experience, ability to motivate others and ability to work as a change agent.
17. Empower and allow Six Sigma team members at every level in the organisation to make decisions to improve performance. Empowerment is also viewed as a top-down process; managers who are not empowered will not empower their subordinates.

18. Choose the Six Sigma project team carefully before the training programme.
19. Encourage through top management the idea of Six Sigma implementation in all departments.
20. Ensure that all organisation employees have received Six Sigma training appropriate to create continuous, fact-based organisational improvement.
21. Use additional and more advanced data analysis tools and project management methodology and tools and include measured financial results for successful implementation of Six Sigma.
22. Invest in the people concept in order to enhance the level of competence. The focus should shift from looking to technology as the whole solution to technology as part of the solution.
23. Put real strategic value into activities, contribute directly to key business goals and objectives and be driven by strategic requirements of markets.
24. Recognise that success is the natural result of right efforts in the right direction on a consistent basis with a holistic approach, bearing in mind the role of culture in the implementation of Six Sigma.
25. Recognise that the right people at the right time are crucial for building and sustaining an organisation's competencies.
26. Ensure that projects are aligned to organisation goals. Six Sigma is less successful if it is too much geared towards short-sighted financial targets that do not have management buy-in.
27. Acknowledge that empowering employees is required to encourage the creation and application of Six Sigma within an organisation. By empowering individuals, they will have more freedom and opportunities to explore new possibilities and approaches. Moreover, through empowerment, employers can value their employees' expertise and help them communicate their knowledge by creating ways to implement Six Sigma successfully.
28. Involve employees with enough skills to be team members and work effectively in any future project.
29. Acknowledge that benchmarking analysis could be done across departments in the organisation or organisation-wide.
30. Recognise that successful implementation of Six Sigma requires changing the way an organisation works and changing the mindset of people. In other words,

there is a need to move people successfully from the old way of doing things to the new way of working, which demands supportive leadership.

31. Support implementation at all levels and training and education must include both hard and soft skills for successful implementation.
32. Finally, the Middle East top management should move from the past authoritarian and control styles to a much more open-minded style. They also need to educate themselves and their employees and motivate them to bring their potential to a full capacity to implement the quality initiatives.

9.7 Directions for Further Research

Despite its attempt to be comprehensive and cover a broad area of research, this study leaves plenty of room for future research on issues generated by the study itself. The following are suggestions that could be the basis for further investigation on this topic.

1. Research on Six Sigma implementation in the Middle East is still in the first stage. There is a need for more research in order to provide more literature related to Six Sigma in the Middle East. The present research may act as a starting point to begin developing such insight.
2. In order to increase the generalisability of the results, a replication of this study in other different countries of the Middle East and in other developing countries is suggested to establish the level of Six Sigma initiative implementation in those countries, and to suggest potential improvements.
3. Further empirical studies should use larger sample sizes and greater geographical diversity of Middle East countries that may be helpful in validating the findings of this study.
4. This study demonstrated the significance of culture in affecting Six Sigma implementation. However, this should go further to explore and examine the role of Six Sigma in building quality culture, how culture works and how to link it with productivity and competitiveness.
5. Using similar investigative procedures within the more culturally close countries of the Gulf region would prove useful for comparison with these Middle East findings. The mechanism of culture is unfortunately not substantiated in this research and this needs further work.

6. The importance of top management commitment and involvement in successful Six Sigma implementation is already identified as a vital factor in this research. There is clear evidence that the top management commitment and involvement is very critical to its success. However, there is a greater need to test and verify this aspect. This could open room for further research into Six Sigma implementation with greater focus on the impact of top management's involvement. So, future researches are needed to explore the role of top management across Middle East organisations in order to find out why there has been a lack of commitment and support for the Six Sigma initiative to be successful and how they can be the catalyst during the whole stage of implementation.
7. This research represents a snapshot of people's perception at a particular time. Replication of the study in the Middle East over a longer period would build significantly on the findings. It is however suggested that such a study should be made only after a lapse of time so that a new sample could be found. Another alternative would be to study the implementation process over a longer time in great detail.
8. Another promising research topic for further study is to investigate the link between implementation of Six Sigma and organisational performance in Middle East organisations. Thus, it needs a systematic research to investigate the impact of Six Sigma on business performance which would be better understood in different environments.
9. Since the application of Six Sigma is new to customer satisfaction research, much research on the topic is yet to be conducted. From the researcher's perspective, the key issue is to determine how to use Six Sigma analysis to evaluate and improve customer satisfaction.
10. Future research is needed to validate the model in other various Middle East organisations in different sectors and sizes.

9.8 Chapter Summary

In this concluding chapter, an overall summary of the research was presented, the research questions and objectives were evaluated and addressed, the research design and methodology, data collection and data analysis were summarised and reviewed and the key research findings were summarised and critically discussed. Research contributions were outlined as they added theoretical, methodological and practical new contributions to the literature and to the implementation of Six Sigma in the Middle East organisations. Furthermore, the limitations of the study were discussed. In addition, the chapter presented the conclusions of the research findings and based on the results a necessary number of recommendations towards improving Six Sigma implementation in Middle East organisations and other developing countries organisations were given, which should help to contribute to a successful and effective implementation of Six Sigma in the Middle East. Finally, based on the results of this study, several directions for future research were proposed and discussed.

The study has attempted to bridge the research gap by contributing to the wealth of literature on Six Sigma implementation in the Middle East. This research has led to interesting and important findings by answering and covering all its objectives and has identified a series of critical issues that must be carefully considered to ensure successful implementation of a Six Sigma project. In addition, the findings are empirically valid, the responses to the questions were positive, because all answers were almost consistent and agreed in the responses of the survey questionnaire results. This research has attempted to explore the implementation status of Six Sigma in the Middle East organisations. It identifies the reasons for/ benefits of implementing Six Sigma, its challenges and the CSFs for its effective implementation. The research concludes by proposing a model for successful and effective implementation of Six Sigma in the Middle East.

9.9 Concluding Remarks

From his own experience and as a certified Six Sigma Black Belt (CSSBB) and field visitor to a number of different organisations in Saudi Arabia, the researcher is quite confident about the future of Six Sigma in Middle East organisations and for Six Sigma professionals as well. Although Six Sigma implementation in the Middle East is still in its infancy, the introduction and implementation of Six Sigma are spreading at a greater speed in systematic improvement. For Middle East organisations to remain successful there must be continual adaption and improvement of products and services in order to stay ahead of the competition while meeting all customer needs.

The researcher decided to make this study in the field of Six Sigma quality management because the more he studied the subject of quality, the more he discovered that quality management can help his society to overcome the culture and poor quality which prevent people from moving towards a better standard of living and a better quality of life. The researcher is sure that Six Sigma will not only give a boost to the organisations but also give a chance for Six Sigma professionals to excel in their career development. The view of the researcher is that most Middle East organisations have good opportunities to implement the Six Sigma project successfully. These opportunities include experience taken from previous quality improvement initiatives and successful Six Sigma implementation in some projects. Organisations in the Middle East have to move forward to Six Sigma in the near future if they want to excel and compete with the industrial and commercial giants ready to come to the Middle East. In addition, the key to a successful beginning may be to simplify the Six Sigma process and start small. In the researcher's opinion, the integration of Six Sigma with other improvement strategies will be the next improvement step for organisations. The researcher hopes to see in the future the integration of Six Sigma in a holistic quality improvement strategy in an organisation rather than treating it as a separate initiative for improving process, product and service quality.

Finally, it is hoped that readers of this thesis will first gain a full understanding of the nature and current status of Six Sigma implementation in the Middle East, the reasons for implementing it, its benefits, the challenges to be faced, its CSFs and the organisation satisfaction level from the results achieved from their implementation of Six Sigma and how it can be implemented so as to best fit any type of organisation, in whatever sector, and be provided with a road map for implementation, whether they have been engaged in Six Sigma for several years or are just starting to learn and apply it. Also, it is hoped the empirical findings presented in this research can aid the Middle East organisations in their Six Sigma project implementation. As much as possible, the researcher has done his best to structure the thesis in such a way that it allows the readers to follow the process easily and smoothly.

As final remarks to this study, the researcher wishes to conclude by drawing attention to the following:

- Six Sigma success happens 'one project at a time'.
- Implementation of Six Sigma is a major task for any organisation, it cannot be accomplished overnight. It is, rather, a long-term, continuous commitment to improving quality and performance. Hence, organisations must be willing to show solid commitment at all levels and training and education must include all required skills for these efforts, because results are almost always not instantaneous.
- Six Sigma is simply a highly disciplined process that helps organisations focus on developing and delivering nearly perfect products and services. In addition, the Six Sigma approach identifies and eliminates defects with a structured, data-driven, problem-solving method of using rigorous data-gathering and statistical analysis.
- Six Sigma is applicable to all sizes of organisations, from SMEs to very large multi-nationals, and to all sectors (manufacturing and services) in the Middle East. These findings are very important for the implementation of Six Sigma in all the Middle East organisations.
- The Six Sigma journey requires patience and discipline, because it deals fundamentally with improvement.
- Six Sigma project success is the natural result of right efforts in the right direction on a consistent basis with a holistic approach, bearing in mind the role of culture in Six Sigma implementation.
- Six Sigma has been the phenomenon credited for the breakthrough success of many of today's top-performing organisations.
- Good Six Sigma project selection leads to a large financial impact.
- A successful Six Sigma programme must become a cultural revolution involving every person in an organisation.
- Success has to be defined in terms of achievement of some predetermined goals, i.e., improved efficiency and lower costs, improved speed, customer needs and greater market share.
- Implementation of Six Sigma is hard work, not magic; bumps in the road are to be expected but by sticking to the route, results will occur.

- Finally, in this researcher's view, the Six Sigma implementation programme in the Middle East organisations has to be seen as being

  '*a continuous journey, not a destination*'.

BIBLIOGRAPHY

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The following are the more relevant literature read or reviewed while writing this thesis. They are reviewed or cited specifically highlighted in this thesis and were all used in some way to help guide its writing.

Aaker, D. A., Kumar, V. and Day, G. S. (1997). *Correlation Analysis and Regression Analysis.* (6th ed.). Marketing Research, John Wiley and Sons, Inc.

Abernathy, D. P. (2001). 'Avoiding unintended consequences: managing 'Anti-Ys' in a Six Sigma project'. ASQ *Annual Quality Congress Proceedings*, Milwaukee: ASQ Quality Press, pp. 561-567.

Aboelmaged, M. G. (2010). 'Six Sigma quality: a structured review and implications for future research'. *International Journal of Quality and Reliability Management*, Vol. 27, No. 3, pp. 268-317.

Abraham, B. and Mackay, J. (2001). 'Six Sigma black belts: what do they need to know?'. *Journal of Quality Technology*, Vol. 33, No. 4, pp. 410-413.

Abramowich, E. (2005). *Six Sigma for growth: driving profitable top-line results.* Singapore; Hoboken: John Wiley.

Achanga, P., Shehab, E., Roy, R. and Nelder, G. (2006). 'Critical success factors for lean implementation within SMEs'. *Journal of Manufacturing Technology Management*, Vol. 17, No. 4, pp. 460-471.

Adams, C. W., Gupta, P. and Wilson, C. E. (2003). *Six Sigma deployment.* Boston: Butterworth-Heinemann.

Adams, G. R. and Schvaneveldt, J. D. (1991). *Understanding research methods.* (2nd ed.). New York: Longman.

Ahire, S. L. and O'Shaughnessy, K. C. (1998). 'The role of top management commitment in quality management: an empirical analysis of the auto parts industry'. *International Journal of Quality Science*, Vol. 3, No. 1, pp. 5-37.

Air Academy Associates (1998). *Sony: Six Sigma greenbelt training.* Colorado Springs, CO: Air Academy Press.

Akpolat, H. (2004). *Six Sigma in transactional and service environments.* Aldershot: Gower.

Aksoy, E. and Dinçmen, M. (2004). 'Managing knowledge assets for process excellence - knowledge for Six Sigma'. *Proceedings of Advances in Management Research Conference.* Berlin, November, pp. 69-82.

Alldredge, A. D. (1993). *Application of Six Sigma concepts to a facilities organization,* Motorola University Press.

Allen, T. T. and Brady, J. E. (1998). 'Six Sigma literature: a review and agenda for future research'.

AlliedSignal Inc. (1998). *Annual Report.* [online] Available: http://www.honeywell.com [accessed 07/5/2008].

Al-Mashari, M. and Zairi, M. (1999a). 'BPR implementation process: an analysis of key success and failure factors'. *Business Process Management Journal*, Vol. 5, No. 1, pp. 87-112.

Al-Mashari, M. and Zairi, M. (1999b). 'Revisiting BPR: a holistic review of practice and development'. *Business Process Management Journal*, Vol. 6, No. 1, pp. 10-42.

Amar, K. and Davis, D. (2008). 'A Review of Six Sigma Implementation Frameworks and Related Literature'. *Proceedings of the International Multi Conference of Engineers and Computer Scientists*, Vol. II, IMECS, 19-21 March, Hong Kong.

Alreck, P. L. and Settle, R. B. (1995). *The survey research handbook: guidelines and strategies for conducting a survey.* Chicago, Irwin.

Ambro, M. (2004). 'Total quality system as a product of the empowered corporate culture'. *The TQM Magazine*, Vol. 16, No. 2, pp. 93-104.

American Society for Quality (ASQ) (2003). *Six Sigma glossary.* [online] Available: http://www.asq.org/index.html [accessed 21/4/2008].

Anbari, F. T. (2002). 'Six Sigma method and its applications in project management'. *Proceedings of the Project Management Institute (PMI) Annual Seminars and Symposium,* San Antonio, Texas.

Anbari, F. T. and Kwak, Y. H. (2004). 'Success factors in managing Six Sigma projects'. *Proceedings Project Management Institute Research Conference,* London, 11-14 July.

Anderson, M. J. and Kraber, S. L. (2002). 'Cost effective and information efficient robust design for optimizing processes and accomplishing Six Sigma objectives'. *Annual Quality Congress Proceedings,* Milwaukee: ASQ Quality Press, pp. 141-149.

Anderson, R., Eriksson, H. and Torstensson, H. (2006). 'Similarities and differences between TQM, Six Sigma and Lean'. *The TQM Magazine,* Vol. 18, No. 3, pp. 282-296.

Annamalai, C. (2008). 'Combining innovation with Six Sigma'. *ASQ Six Sigma Forum Magazine,* Vol. 7, No. 2, pp. 36-37.

Anonymous (1998a). 'The fundamentals of Six Sigma'. *Quality Progress,* Vol. 31, No. 6, pp. 36-37.

Anonymous (1998b). 'What have been the results of Six Sigma?'. *Quality Progress,* Vol. 31, No. 6, p. 39.

Anonymous (2003a). 'Six Sigma for success in healthcare'. *Quality Progress,* Vol. 36, No. 9, pp. 67-70.

Anonymous (2003b). 'Six Sigma implementation'. *Measuring Business Excellence,* Vol. 7, No. 3, pp. 57-60.

Anonymous (2003c). 'Software for Six Sigma contains specialized tools'. *Quality Progress,* Vol. 36, No. 6, pp. 95-95.

Anonymous (2003d). 'Study of Six Sigma reveals gains and missed potential'. *Strategic Direction,* Vol. 19, No. 8, pp. 34-36.

Anonymous (2004a). 'Get in step with Six Sigma'. *Quality Progress,* Vol. 37, No. 12, pp. 79-81.

Anonymous (2004b). 'Six Sigma and management'. *Quality,* Vol. 43, No. 11, pp. 42-45.

Anonymous (2004c). 'Six Sigma quality implemented by Bosch'. *SDM,* Vol. 34, No. 11, p. 20.

Anonymous (2005a). 'A crash course in Six Sigma'. *Health Care Strategic Management,* Vol. 23, No. 12, p. 14.

Anonymous (2005b). 'Accelerating Six Sigma rollout'. *Quality,* Vol. 44, No. 6, pp. 44-49.

Anonymous (2006a). 'Is Six Sigma a good fit for your business?'. *Quality Progress,* Vol. 39, No. 1, pp. 73-76.

Antony, J. (2000). 'Ten key ingredients for making SPC successful in organisations'. *Measuring Business Excellence,* Vol. 4, No. 4, pp. 7-10.

Antony, J. (2002a). '12 critical success factors for Six Sigma effectiveness'. *Measuring Business Excellence,* Vol. 6, No. 3, pp. 68-69.

Antony, J. (2002b). 'Design for Six Sigma: a breakthrough business improvement strategy for achieving competitive advantage'. *Work Study,* Vol. 51, No. 1, pp. 6-8.

Antony, J. (2004a). 'Six Sigma in the UK service organisations: results from a pilot survey'. *Managerial Auditing Journal,* Vol. 19, No. 8, pp. 1006-1013.

Antony, J. (2004b). 'Some pros and cons of Six Sigma: an academic perspective'. *The TQM Magazine,* Vol. 16, No. 4, pp. 303-306.

Antony, J. (2005a). 'Assessing the status of Six Sigma in the UK service organisations'. *Proceedings Second National Conference on Six Sigma,* Wroclaw, pp.1-12.

Antony, J. (2006). 'Six Sigma for service processes'. *Business Process Management Journal,* Vol. 12, No. 2, pp. 234-248.

Antony, J. (2007a). 'Is Six Sigma a management fad or fact?'. *Assembly Automation,* Vol. 27, No. 1, pp. 17-19.

Antony, J. (2007b). 'Six Sigma: a strategy for supporting innovation in pursuit of business excellence'. *International Journal for Technology Management,* Vol. 37, No. 1, pp. 8-12.

Antony, J. (2008a). 'What is the role of academic institutions for the future development of Six Sigma?'. *International Journal of Productivity and Performance Management,* Vol. 57, No. 1, pp. 107-110.

Antony, J. (2008b). 'Can Six Sigma be effectively implemented in SMEs?'. *International Journal of Productivity and Performance Management,* Vol. 57, No. 5, pp. 420-423.

Antony, J. (2009). 'Six Sigma vs. TQM: some perspectives from leading practitioners and academics'. *International Journal of Productivity and Performance Management,* Vol. 58, No. 3, pp. 274-279.

Antony, J. and Banuelas, R. (2001). 'A strategy for survival'. *Manufacturing Engineering,* Vol. 80, No. 3, pp. 119-121.

Antony, J. and Banuelas, R. (2002). 'Key ingredients for the effective implementation of Six Sigma programme'. *Measuring Business Excellence,* Vol. 6, No. 4, pp. 20-27.

Antony, J. and Bhaji, M. (2005). *Key ingredients for a successful Six Sigma programme.* Warwick Manufacturing Group, School of Engineering, University of Warwick, UK.

Antony, J. and Coronado, R. (2002a). 'Critical success factors for the successful implementation of Six Sigma projects in organisations'. *The TQM Magazine,* Vol. 14, No. 2, pp. 92-99.

Antony, J. and Coronado, R. (2002b). 'Design for Six Sigma'. *Manufacturing Engineering,* Vol. 81, No. 1, pp. 24-26.

Antony, J. and Fergusson, C. (2004). 'Six Sigma in the software industry: results from a pilot study'. *Managerial Auditing Journal,* Vol. 19, No. 8, pp. 1025-1032.

Antony, J., Antony, F. J., Kumar, M. and Cho, B. R. (2007). 'Six Sigma in service organisations: benefits, challenges and difficulties, common myths, empirical observations and success factors'. *International Journal of Quality and Reliability Management,* Vol. 24, No. 3, pp. 294-311.

Antony, J., Balbontin, A. and Taner, T. (2000). 'Key ingredients for the effective implementation of statistical process control (SPC)'. *Work Study,* Vol. 49, No. 6, pp. 242-247.

Antony, J., Bañuelas, R. and Kumar, A. (2006). *World class applications of Six Sigma: real world examples of success.* Boston: Elsevier Science.

Antony, J., Douglas, A. and Antony, F. J. (2007). 'Determining the essential characteristics of Six Sigma black belts - results from a pilot study in UK manufacturing companies'. *The TQM Magazine,* Vol. 19, No. 3, pp. 274-281.

Antony, J., Downey-Ennis, K., Antony, F. and Seow, C. (2007). 'Can Six Sigma be the 'cure' for our 'ailing' NHS?'. *Leadership in Health Services,* Vol. 20, No. 4, pp. 242-253.

Antony, J., Escamilla, J. L. and Caine, P. (2003). 'Lean Sigma'. *Manufacturing Engineer,* Vol. 82, No. 2, pp. 40-42.

Antony, J., Kumar, M. and Madu, C. N. (2005). 'Six Sigma in small-and medium-sized UK manufacturing enterprises: some empirical observations'. *International Journal of Quality and Reliability Management,* Vol. 22, No. 8, pp. 860-874.

Arcidiacono, G. (2006). 'Keys to success for Six Sigma'. *Proceedings of 4th International Conference on Axiomatic Design,* Firenze, June 13-16. ICAD-2006-47.

Arnheiter, E. and Maleyeff, J. (2005). 'The integration of lean management and Six Sigma'. *The TQM Magazine,* Vol. 17, No. 1, pp. 5-18.

Arthur, J. (2001). *Six Sigma simplified: quantum improvement made easy* (2nd ed.). Denver: Life Star.

Attenello, D. and Uzzi, J. (2002). 'Achieving Six Sigma quality in financial services'. *ASQ Six Sigma Forum Magazine,* Vol. 1, No. 2, pp. 18-22.

Austin, T. E. (2006). 'Application of Six Sigma methodologies to improve requirements management for customer programmes'. *SAE World Congress.* Detroit, Michigan, April 3-6, pp. 1-6.

Averboukh, E. A. (2003). 'Six Sigma trends: management of Six Sigma deployment'. [online] Available: http://www.isixsigma.com. [accessed 17/7/2008].

Ayeni, F. O. (2004). *An empirical study of the impact of Six Sigma methodology on organization financial performance in the United States*. PhD Dissertation, Regent University.

Babbie, E. (1990). *Survey research methods*. Belmont: Wadsworth Publication.

Babbie, E. (2004). *The practice of social research*. (10th ed.). Belmont: Thomson/Wadsworth.

Badri, M. A. and Davis, D. (1995). 'A study of measuring the critical factors of quality management'. *International Journal of Quality and Reliability Management*, Vol. 12, No. 2, pp. 36-53.

Baetke, M., Hammer, L. and Zalesky, S. (2002). 'Six Sigma'. *Quality Culture Mini Paper*. Iowa State University, September.

Bagozzi, R. P. (1994). *Principles of marketing research*. Cambridge; Oxford: Blackwell Business.

Bagozzi, R. P., Yi, Y. and Phillips, L. W. (1991). 'Assessing construct validity in organizational research'. *Administrative Science Quarterly*, Vol. 36, pp. 421-458.

Bailey, K. D. (1990). *Methods of social research*. New York: Wiley.

Bailey, M. (2007). 'The master black belt - what is needed beyond the basics?'. *ASQ Six Sigma Forum Magazine*, Vol. 6, No. 3, pp. 32-33.

Bailey, S. P. (2001). 'Six Sigma black belts: what do they need to know?'. *Journal of Quality Technology*, Vol. 33, No. 4, pp. 426-431.

Bailey, S. P., Mitchell, R. H., Vining, G. and Zinkgraf, S. (2001). 'Six Sigma: a breakthrough strategy or just another fad?' *Annual Quality Congress Proceedings*, Milwaukee, pp. 1-3.

Bajaria, H. J. (1999a). 'Six Sigma quality: points and counterpoints'. *Quality Australia*, Vol. 15, No. 1, pp. 15-17.

Bajaria, H. J. (1999b). 'Six Sigma moving beyond the hype'. *Annual Quality Congress Proceedings*, Milwaukee: ASQ, pp.1-3.

Baker, T. L. (1999). *Doing social research* (3rd ed.). International Edition Sociology Series. London: McGraw-Hill.

Balnaves, M. and Caputi, P. (2001). *Introduction to qualitative research methods: an investigative approach*. London: Sage.

Bandyopadhyay, J. K. and Lichtman, R. (2007). 'Six Sigma approach to quality and productivity improvement in an institution in higher education in US'. *International Journal of Management*, Vol. 24, No. 4, pp. 802-809.

Bank, J. (1992). *The essence of total quality management*. Great Britain: Prentice Hall.

Bañuelas, R. and Antony, J. (2003). 'Going from Six Sigma to design for Six Sigma: an exploratory study using Analytic Hierarchy Process (AHP)'. *The TQM Magazine*, Vol. 15, No. 5, pp. 334-344.

Bañuelas, R. and Antony, J. (2004). 'Six Sigma or design for Six Sigma?'. *The TQM Magazine*, Vol. 16, No. 4, pp. 250-263.

Bañuelas, R., Antony, J. and Brace, M. (2005). 'An application of Six Sigma to reduce waste'. *Quality and Reliability Engineering International*, Vol. 21, No. 5, pp. 553-570.

Bañuelas, R., Tennant, C., Tuersley, I. and Tang, S. (2006). 'Selection of Six Sigma projects in the UK'. *The TQM Magazine*, Vol. 18, No. 5, pp. 514-527.

Barney, J. B. (1986). 'Organizational culture: Can it be a source of sustained competitive advantage?' *The Academy of Management Review*, Vol. 11, No. 3, pp. 656-665.

Barney, M. (2002). 'Motorola's second generation'. *ASQ Six Sigma Forum Magazine*, Vol. 1, No. 3, May, pp. 13-16.

Barney, M. and McCarty, T. (2003). *The new Six Sigma: a leader's guide to achieving rapid business improvement and sustainable results*. Upper Saddle River: Prentice-Hall.

Baron, D. (2006). 'A communicator's primer on Six Sigma'. *Strategic Communication Management*, Vol. 10, No. 4, pp. 8-9.

Barry, R. D. and Smith, A. C. (2005). *The manager's guide to Six Sigma in healthcare: practical tips and tools for improvement*. Milwaukee: ASQ Quality Press.

Barry, R., Murcko, A. and Brubaker, C. (2002). *The Six Sigma for healthcare: improving outcomes by reducing errors*. Chicago: Health Administration Press.

Barth, J. M. (2005). 'Six Sigma: more than just a cost saving'. *ASQ Six Sigma Forum Magazine,* Vol. 4, No. 2, pp. 48-50.

Bartos, F. (1999). 'Six Sigma for complex systems'. *Control Engineering*, Vol. 46, No. 3, pp. 90.

Basu, R. (2001). 'Six Sigma to fit sigma'. *IIE Solution*, Vol. 33, No. 7, pp. 28-34.

Basu, R. (2004). 'Six Sigma to operational excellence: the role of tools and techniques'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 44-64.

Basu, R. and Wright, J. N. (2004). *Quality beyond Six Sigma*: New York: Butterworth Heinemann.

Behara, R. S. and Lemmink, J. (1997). 'Benchmarking field services using a zero defects approach'. *International Journal of Quality and Reliability Management*, Vol. 14, No. 5, pp. 512-526.

Behara, R. S., Fontenot, G. F. and Gresham, A. (1995). 'Customer satisfaction measurement and analysis using Six Sigma'. *International Journal of Quality and Reliability Management*, Vol. 12, No. 3, pp. 9-18.

Belair, G. and O'Neill, J. (2007). *Implementing design for Six Sigma: a leader's guide: getting the most from your product development process.* Milwaukee: ASQ Quality Press.

Bell, J. (2005). *Doing your research project: a guide for first-time researchers in education, health and social science*. Maidenhead: Open University Press.

Bellanca, R. (2003). *Managing Six Sigma change resistance*. [online] Available: http://www.isixsigma.com [accessed 1/10/2008].

Benbow, D. W. and Kubiak, T. M. (2005). *The certified Six Sigma black belt handbook.* Milwaukee: ASQ Quality Press.

Bendell, T. (2006). 'A review and comparison of Six Sigma and the Lean organisations'. *The TQM Magazine*, Vol. 18, No. 3, pp. 255-262.

Benedetto, A. R. (2003). 'Adapting manufacturing-based Six Sigma methodology to the service environment of a radiology film library'. *Journal of Healthcare Management*, Vol. 48, No. 4, pp. 263-280.

Berger, A. (2003). *Smart things to know about Six Sigma.* Oxford: Capstone Publishing.

Bergman, B. and Klefsjo, B. (2003). *Quality from customer needs to customer satisfaction.* Studentlitteratur: Lund.

Bergman, B. and Kroslid, D. (2000). 'Six Sigma: a revival of the profound knowledge of variation'. *Proceedings of the Third International Conference on Building People and Organizational Excellence*, pp. 260-266.

Bernard, H. R. (2000). *Social research methods: qualitative and quantitative approaches.* Thousand Oaks; London: Sage.

Berry, T. H. (1991). *Managing the total quality transformation*. New York: McGraw-Hill.

Berry, W. and Feldman, S. (1985). *Multiple regression in practice.* Sage.

Bertels, T. (2003). *Rath and Strong's Six Sigma leadership handbook.* Hoboken: Wiley.

Bertels, T. and Patterson, G. (2003). 'Selecting Six Sigma projects that matter'. *ASQ Six Sigma Forum Magazine*, Vol. 3, No. 1, pp. 13-15.

Best Practices (2001). *Building Six Sigma excellence: a case study of General Electric.* Chapel Hill.

Best Practices (2004). *Lean, Six Sigma and TQM project success: recent case studies and benchmarks*. Chapel Hill.

Bhote, K. R. (2002). *The ultimate Six Sigma: beyond quality excellence to total business excellence*. New York: American Management Association.

Bhote, K. R. (2003). *The power of ultimate Six Sigma.* New York: American Management Association.

Bhuiyan, N. and Baghel, A. (2005). 'An overview of continuous improvement: from the past to the present'. *Management Decision*, Vol. 43, No. 5, pp. 761-771.

Bicheno, J. (2002). *The quality 75: towards Six Sigma performance in service and manufacturing*. Buckingham: PICSIE.

Bickman, L. and Rog, D. J. (1998). *Handbook of applied social research methods*. Thousand Oaks: Sage.

Bisgaard, S. and Freiesleben, J. (2001). 'Economics of Six Sigma programmes: quality quandaries'. *Quality Engineering*, Vol. 13, No. 2, pp. 325-331.

Bisgaard, S. and Freiesleben, J. (2004). 'Six Sigma and the bottom line'. *Quality Progress*, Vol. 37, No. 9, pp. 57-62.

Bisgaard, S., Hoerl, R. W. and Snee, R. D. (2002). 'Improving business processes with Six Sigma'. *Annual Quality Congress Proceedings*, Milwaukee, pp.701-704.

Black, K. and Mcglashan, R. (2004). 'Essential characteristics for Six Sigma black belt candidates: a study of US companies'. *1st International Conference on Six Sigma*, 16-17 December, Glasgow.

Black, K. and Revere, L. (2006). 'Six Sigma arises from the ashes of TQM with a twist'. *International Journal of Health Care Quality Assurance*, Vol. 19, No. 3, pp. 259-266.

Black, S. A. and Porter, L. J. (1996). 'Identification of the critical factors of TQM'. *Decision Science*, Vol. 27, No. 1, pp. 1-21.

Blakeslee, J. A. (1999a). 'Achieving quantum leaps in quality and competitiveness: implementing the Six Sigma solution in your company'. *Annual Quality Congress Proceedings*, Milwaukee, pp. 486-496.

Blakeslee, J. A. (1999b). 'Implementing the Six Sigma solution - how to achieve quantum leaps in quality and competitiveness'. *Quality Progress*, Vol. 32, No. 7, pp. 77-85.

Blashka, S. E. (2004). *Six Sigma management a guide for your journey to best-practice processes*. Houston: APQC.

Blaxter, L., Hughes, C. and Tight, M. (2001). *How to research*. Buckingham: Open University Press.

Bless, C. and Higson-Smith, C. (2004). *Fundamentals of social research methods*. (3rd ed.). Lusaka: Juta.

Bloisi, W., Cook, C. W. and Hunsaker, P. L. (2003). *Management and organizational behaviour*. Maidenhead: McGraw-Hill Education.

Bolze, S. (1998). 'A Six Sigma approach to competitiveness'. *Transmission and Distribution World*, Vol. 50, No. 8, p. 18.

Bonnie, S. (2003). ' Lean and Six Sigma - a one-two punch'. *Quality Progress*, Vol. 36, No. 4, April, pp.18-24.

Bordens, K. S. and Abbott, B. B. (2002). *Research design and methods: a process approach*. New York; London: McGraw-Hill.

Bothe, D. (2001). 'Statistical reason for the 1.5 sigma shift'. *Quality Engineering*, Vol. 14, No. 3, pp. 479-488.

Bott, C., Keim, E., Kim, S. and Palser, L. (2000). 'Service quality Six Sigma case studies'. *Annual Quality Congress Proceedings*, Milwaukee, pp. 225-234.

Bouma, G. D. and Atkinson, G. J. (1995). *A handbook of social scientific research*. Oxford: Oxford University Press.

Bourque, L. B. and Fielder, E. P. (1995). *How to conduct self-administered and mail surveys*. London: Sage.

Bowen, P. W. (1996). 'The need for quality cultures'. *Training for Quality*, Vol. 4, No. 2, pp. 14-18.

Bowman, R. (1997). 'Best practices: the joy of Six Sigma'. *Distribution*, August.

Brady, J. E. (2005). *Six Sigma and the university: teaching, research and analysis. Industrial and Systems Engineering*. PhD Thesis, The Ohio State University.

Brady, J. E. and Allen, T. T. (2006). 'Six Sigma literature: a review and agenda for future research'. *Quality and Reliability Engineering International*, Vol. 22, pp. 335-367.

Brannen, J. (1995). *Mixing methods: qualitative and quantitative research*. Aldershot: Brookfield.

Bremer, M., McKibben, B. and McCarty, T. (2006). *Six Sigma financial tracking and reporting*. New York: McGraw-Hill.

Brewer, J. and Hunter, A. (1989). *Multi-method research: a synthesis of styles.* Newbury Park: Sage.

Brewer, P. C. (2004). 'Six Sigma help a company create a culture of accountability'. *Journal of Organisational Excellence*, Vol. 23, No. 3, pp. 45-60.

Brewer, P. C. and Bagranoff, N. A. (2004). 'Near zero-defect accounting with Six Sigma'. *The Journal of Corporate Accounting and Finance*, Vol. 15, No. 2, pp. 67-72.

Brewer, P. C. and Eighme, J. E. (2005). 'Using Six Sigma to improve the finance function'. *Strategic Finance*, Vol. 86, No. 11, pp. 26-33.

Breyfogle, F. W. (1999a). 'Implementing Six Sigma: Part 1'. *The Quality Management Forum*, April.

Breyfogle, F. W. (1999b). 'Implementing Six Sigma: Part 2'. *The Quality Management Forum*, April.

Breyfogle, F. W. (2003a). *Implementing Six Sigma: smarter solutions using statistical methods.* New Jersey: John Wiley.

Breyfogle, F. W. (2003b). 'Six Sigma methods to ensure organization's health'. *RandD Magazine*, April, pp. 28-29.

Breyfogle, F. W. (2005). '21 Common problems and what to do about them'. *ASQ Six Sigma Forum Magazine*, Vol. 4, No. 4, pp. 35-37.

Breyfogle, F. W. and Connolly, M. (2003). 'Six Sigma methods to ensure organisations health'. *RandD Magazine*, Vol. 45, No. 4, pp. 28-29.

Breyfogle, F. W. and Enck, D. (2002). 'Six Sigma goes corporate'. *Business Management*, May, p. 70.

Breyfogle, F. W. and Meadows, B. (2001). 'Bottom-line success with Six Sigma- Define key process output variables and their effects on the cost of poor quality'. *Quality Progress*, Vol. 34, No. 5, pp. 101-104.

Breyfogle, F. W., Cupello, J. M. and Meadows, B. (2001a). *Managing Six Sigma: a practical guide to understanding, assessing, and implementing the strategy that yields bottom-line success.* New York: John Wiley.

Breyfogle, F. W., Cupello, J. M. and Meadows, B. (2001b). 'Six Sigma Black Belts: What do they need to know?' *Journal of Quality Technology*, Vol. 33, No. 4, pp. 424-425.

Bright, K. and Cooper, C. L. (1993). 'Organizational culture and the management of quality'. *Journal of Management Psychology*, Vol. 8, No. 6, pp. 21-27.

Brook, Q. (1995). *World class logistics: The challenge of managing continuous change.* Council of Logistics Management.

Brook, Q. (2004). *Six Sigma and Minitab: a toolbox guide for managers, black belts and green belts.* Surrey: QSB Consulting.

Brown, M. G. (1996). *Keeping score: using the right metrics to drive world-class performance.* Portland: Productivity Inc.

Brown, M. G., Hitchcock, D. E and Willard, M. L. (1994). *Why TQM fails and what to do about it.* New York: Irwin Professional Publishing.

Brue, G. (2003a). *Design for Six Sigma.* New York: McGraw-Hill.

Brue, G. (2003b). *Six Sigma for managers.* New York: McGraw-Hill.

Brue, G. (2004). 'Get the real thing with Six Sigma'. *American Banker*, Vol. 169, No. 93, pp. 11-15.

Brue, G. (2005). *Six Sigma for managers: 24 lessons to understand and apply Six Sigma principles in any organisation.* New York: McGraw-Hill.

Brue, G. (2006). *Six Sigma for small business*, Madison, Entrepreneur Press.

Brue, G. and Howes, R. (2006). *Six Sigma.* New York: McGraw-Hill.

Brue, G. and Launsby, R. (2003). *Design for Six Sigma.* New York: McGraw-Hill.

Brussee, W. (2004). *Statistics for Six Sigma made easy!.* New York: McGraw-Hill.

Brussee, W. (2006). *All about Six Sigma: the easy way to get started.* New York; London: McGraw-Hill.

Bryman, A. (1984). 'The debate about quantitative and qualitative research: a question of methods or epistemology?'. *The British Journal of Sociology*, Vol. 35, No. 1, pp. 75-92.

Bryman, A. (2004). *Social research methods.* (2nd ed.). Oxford: Oxford University Press.

Bryman, A. and Cramer, D. (1998). *Quantitative data analysis for social scientists.* (2nd ed.). London: Routledge.

Bryman, A. and Cramer, D. (2001). *Quantitative data analysis with SPSS 10 for Windows: a guide for social scientists.* London: Routledge.

Buch, K. and Rivers, D. (2001). 'TQM: the role of leadership and culture'. *Leadership and Organizational Development Journal,* Vol. 22, No. 8, pp. 365-371.

Buch, K. K. and Tolentino, A. (2006a). 'Employee expectancies for Six Sigma success'. *Leadership and Organization Development Journal,* Vol. 27, No. 1, pp. 28-37.

Buch, K. K. and Tolentino, A. (2006b). 'Employee perceptions of the rewards associated with Six Sigma'. *Journal of Organizational Change Management,* Vol. 19, No. 3, pp. 356-364.

Buck, C. (1998). 'Healthcare through a Six Sigma lens'. *Milbank Quarterly,* Vol. 76, No. 4, pp. 749-754.

Buck, C. (2001). 'What Hospital leaders say about Six Sigma'. *Hospitals and Health Networks,* Vol. 75, No. 12, p. 43.

Buck, C., Miller, R. and Desmarais, J. (2001). 'Six Sigma - the quest for quality'. *Hospitals and Health Networks,* Vol. 75, No. 12, pp. 41-48.

Buggie, F. D. (2000). 'Beyond Six Sigma'. *Journal of Management in Engineering,* Vol. 16, No. 4, pp. 28-31.

Burgess, R. (1984). *In the field: an introduction to field research.* London: George Allen and Unwin Ltd.

Burns, A. C. and Bush, R. F. (1995). *Marketing Research.* Prentice Hall, Englewood Cliffs.

Burton, T. T. (2006). *Is this a Six Sigma, Lean, or Kaizen project?* [online] Available: http://www.isixsigma.com/library/content/c020204a.asp, [accessed 18/08/2008].

Burton, T. T. and Sams, J. L. (2005). *Six Sigma for small and mid-sized organizations: success through scaleable deployment.* Florida, Ross Publications.

Bushell, S. (1992). 'Implementing plan, do, check and act'. *The Journal for Quality and Participation,* Vol. 15, No. 5, pp. 58-62.

Byars, L. (1991). *Strategic management formulation and implementation - concepts and cases.* New York, NY: HarperCollins.

Byrne, G. (2003). 'Ensuring optimal success with Six Sigma implementations'. *Journal of Organizational Excellence,* Vol. 22, No. 2, pp. 43-50.

Caldwell, K. (2002). 'Six Sigma brings control to the shop floor'. *Quality,* Vol. 41, No. 8, pp. 28-31.

Camgoz-Akdag, H. (2007). 'Total quality management through Six Sigma benchmarking - a case study'. *Benchmarking: An International Journal,* Vol. 14, No. 2, pp. 186-201.

Cao, G., Clarke, S. and Lehaney, B. (2000). 'A systematic view of organisational change and TQM'. *The TQM Magazine,* Vol. 12, No. 3, pp. 186-93.

Card, D. N. (2000). 'Sorting out Six Sigma and the CMM'. *IEEE Software,* Vol. 17, No. 3, pp. 11-14.

Carnell, M. and Lambert, J. (2000). 'Organisational excellence through Six Sigma discipline'. *Measuring Business Excellence,* Vol. 4, No. 2, pp. 18-25.

Carreira, B. and Trudell, B. (2006). *Lean Six Sigma that works: a powerful action plan for dramatically improving quality, increasing speed, and reducing waste.* New York: American Management Association.

Carrigan, M. D. and Kujawa, D. (2006). 'Six Sigma in healthcare management and strategy'. *The healthcare Manager,* Vol. 25, No. 2, pp. 133-141.

Cartin, T. J. (1993). *Principles and practices of TQM.* Milwaukee: ASQC Quality Press.

Catherwood, P. (2002). 'What's different about Six Sigma'. *Manufacturing Engineering,* Vol. 81, No. 8, pp. 186-189.

Caulcutt, R. (2001). 'Why is Six Sigma so successful?'. *Journal of Applied Statistics,* Vol. 28, No. 3, pp. 301-306.

Cavanagh, R. R., Neuman, R. P. and Pande, P. S. (2005). *What is design for Six Sigma?.* New York: McGraw-Hill.

Chakrabarty, A. and Tan, C. K. (2007). 'The current state of Six Sigma application in services'. *Managing Service Quality*, Vol. 17, No. 2, pp. 194-208.

Chan, J., Kwan, R. and Wong, E. (2005). *Quality management: a new era*. Singapore: World Scientific.

Change, F. S. and Wiebe, H. A. (1996). 'The ideal culture profile for total quality management: a competing values perspective'. *Engineering Management Journal*, Vol. 8, No. 2, pp. 19-26.

Chapell, A. (2005). *An investigation into the applicability of the Six Sigma methodology to defence supply chain processes*, MSc Thesis, CLSCM, Cranfield University.

Chaplin, E. (2003). 'The application of Six Sigma strategies to medication administration'. *ASQ Annual Quality Congress Proceedings*, Milwaukee, pp.1-36.

Chase, N. (1999). 'Six Sigma black belts stamp out tough quality problems'. *Quality Magazine*, Vol. 38, No. 9, pp. 32-39.

Chassin, M. (1998). 'Is healthcare ready for Six Sigma quality?'. *Milbank Quarterly*, Vol. 76, No. 4, pp. 565-591.

Chen, C. W. and Roth, H. (2004). *The big book of Six Sigma training games: proven ways to teach basic DMAIC principles and quality improvement tools*. New York; London: McGraw-Hill.

Cheng, J. L. (2007). 'Six Sigma and TQM in Taiwan: an empirical study'. *The Quality Management Journal*, Vol. 14, No. 2, pp. 7-20.

Cheng, J. L. (2008). 'Implementing Six Sigma via TQM improvement: an empirical study in Taiwan'. *The TQM Journal*, Vol. 20, No. 3, pp. 182-195.

Choi, T. Y. and Eboch, K. (1998). 'The TQM paradox: relations among TQM practices, plant performance, and customer satisfaction'. *Journal of Operations Management*, Vol. 17, No. 1, pp. 59-75.

Chollar, G. (2005). *A comparison of Six Sigma, Lean and DFSS*. Statistical Design Institute, LLC.

Chowdhury, S. (2001). 'Working toward Six Sigma success'. *Manufacturing Engineering*, Vol. 127, No. 1, p. 14.

Chowdhury, S. (2003). *The power of Six Sigma: an inspiring tale of how Six Sigma is transforming the way we work*. Chicago: Dearborn Trade Publishing.

Chowdhury, S. (2005). *Design for Six Sigma: the revolutionary process for achieving extraordinary profits*. Chicago: Dearborn Trade Publishing.

Chu, K. F. (2003). 'An organizational culture and the empowerment for change in SMEs in the Hong Kong manufacturing industry'. *Journal of Materials Processing Technology*, Vol. 139, pp. 505-509.

Churchill, G. A. (1999). *Marketing research: methodological foundations*. (7th ed.). Fort Worth; London: Dryden Press.

Clifford, L. (2001). 'How you can safely ignore Six Sigma?'. *Fortune*, Vol. 143, No. 2, pp. 140.

Cohen, J. (1988). *Statistical power for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cohen, J. and Cohen, P. (1983). *Applied multiple regression/correlation analysis of the behavioural science*. (2nd ed.). New Jersey: Lawrence Erlbaum.

Cohen, L., Manion, L. and Morrison, K. (2003). *Research Methods in Education*. (5th ed.). Cornwall: TJ International.

Collis, J. and Hussey, R. (2003). *Business research: a practical guide for undergraduate and postgraduate students*. Basingstoke: Palgrave Macmillan.

Commission of the European Communities (2003). 'Commission recommendations concerning the definition of micro, small, and medium-sized enterprises'. *Official Journal of the European Union*, Vol. 20, No. 5, pp. 36-41.

Comrey, A. L. (1973). *A First Course in Factor Analysis*. San Diego: Academic Press.

Conklin, J. D. (2003). 'Smart Project Selection'. *Quality Progress*, Vol. 36, No. 3, pp. 81-83.

Conlin, M. (1998). 'Revealed at last: the secret of Jack Welch's success'. *Forbes*, Vol. 16, No. 2, January.

Conner, G. (2002). *Six Sigma and other continuous improvement tools for the small shop.* Dearborn: Society of Manufacturing Engineers.

Connolly, M. (2003). 'Six Sigma deployment at DuPont'. *RandD Magazine*, Vol. 45, No. 4, pp. 29.

Connor, G. (2003). 'Benefiting from Six Sigma'. *Manufacturing Engineering*, Vol. 130, No. 2, pp. 53-59.

Cook, B. M. (1990). 'In search of Six Sigma: 99.9997 percent defect-free'. *Industry Week*, Vol. 1, pp. 60-65.

Cook, H. E. (2005). *Design for Six Sigma as strategic experimentation: planning, designing, and building world-class products and services.* Milwaukee: ASQ Quality Press.

Cooke-Davis, T. (2002). 'The real success factors on projects'. *International Journal of Project Management*, Vol. 20, No. 3, pp.185-190.

Coolican, H. (2004). *Research methods and statistics in psychology.* (4th ed.). UK: Hodder and Stoughton.

Cooper, A. H. (2002). 'Six Sigma deployment in a large integrated health system'. *ASQ Annual Quality Congress Proceedings*, Milwaukee, pp.71-77.

Cooper, D. R. and Emory, C. W. (1995). *Research methods.* Homewood, IL: Richard D. Irwin, Inc.

Cooper, D. R. and Schindler, P. S. (2003a). *Ethics in business research methods.* New York: Irwin/McGraw-Hill.

Cooper, D. R. and Schindler, P. S. (2003b). *Business research methods.* Boston; London: McGraw-Hill/Irwin.

Cooper, D., Baabcock, J. and Dipietro, F. (1992). 'Application of Six Sigma - statistical quality control to monitoring the deposition of contaminating particles'. *Journal of the IES*, Vol. 35, No. 5, pp. 27-32.

Cooper, N. P. and Noonan, P. (2003). 'Do teams and Six Sigma go together?'. *Quality Progress*, Vol. 36, No. 6, pp. 25-28.

Cordy, C. E. and Coryea, L. R. (2006). *Champion's practical Six Sigma summary.* United States: Xlibris.

Coronado, R. B. and Antony, J. (2002). 'Critical success factors for the successful implementation of Six Sigma projects in organisations'. *The TQM Magazine*, Vol. 14, No. 2, pp. 92-99.

Crabtree, B. F. and Miller, W. L. (1999). *Doing qualitative research.* (2nd ed). Thousand Oaks; London: Sage.

Cramer, D. (1998). *Fundamental statistics for social research: step-by-step calculations and computer techniques using SPSS for Windows.* London: Routledge.

Creswell, J. W. (2003). *Research design: qualitative, quantitative, and mixed method approaches.* Thousand Oaks; London: Sage.

Creveling, C. M. (2006). *Six Sigma for technical processes: an overview for RandD executives, technical leaders, and engineering managers.* Indianapolis: Prentice-Hall.

Creveling, C. M., Hambleton, L. and McCarthy, B. (2006). *Six Sigma for marketing processes: an overview for marketing executives, leaders, and managers.* Upper Saddle River; London: Prentice Hall.

Crom, S. (2000). 'Implementing Six Sigma - a cross cultural perspective'. *Quality Progress*, Vol. 33, No. 10, pp. 73-76.

Cronbach, L. J. (1984). 'Coefficient alpha and the internal structure of tests'. *Psychometrika*, Vol. 16, pp. 297-334.

Crosby, P. B. (1979). *Quality is free: the art of making quality certain.* New York: McGraw-Hill.

Dachler, H. P. (1997). 'Qualitative methods in organizational research: a practical guide'. *Organization Studies*, Vol.18, No.4, pp.709-724.

Dahlgaard, A. M. (1999). 'The evolution patterns of quality management: Some reflections on the quality movement'. *Total Quality Management*, Vol. 10, No. 4 and 5, pp. 473-480.

Dahlgaard, J. J. and Dahlgaard, S. M. (2006). 'Lean production, Six Sigma quality, TQM and company culture'. *The TQM Magazine*, Vol. 18, No. 3, pp. 263-281.

Dahlgaard, J. J., Kristensen, K. and Kanji, G. K. (1998). *Fundamentals of total quality management*. London: Chapman and Hall.

Dale, B. (1999). *Total quality management blueprint*, Oxford: Blackwell.

Dale, B. and Oakland, J. (1994). *Quality improvement through standards*. (2nd ed.). Stanley Thrones Ltd, UK.

Dale, B. G. (2003). *Managing quality*. (4th ed.), Oxford: Blackwell.

Dambolena, I. and Rao, A. (1994). 'What is Six Sigma anyway?'. *Quality*, Vol. 33, No. 11, pp. 10.

Das, P., Roy, S. and Antony, J. (2007). 'An application of Six Sigma methodology to reduce lot-to-lot shade variation of linen fabrics'. *Journal of Industrial Textiles*, Vol. 36, No. 3, pp. 227-251.

Dasgupta, T. (2003). 'Using the Six Sigma metric to measure and improve the performance of a supply chain'. *Total Quality Management and Business Excellence*, Vol. 14, No. 3, pp. 355-367.

Davis, A. G. (2003). 'Six Sigma for small companies'. *Quality*, Vol. 42, No. 11, pp. 20-21.

Davis, B. (2004). 'How to become a black belt'. *Professional Engineering*, Vol. 17, No. 6, pp. 41-42.

Dean, H. W. and Bowen, D. E. (1994). 'Management theory and total quality: Improving research and practice through theory development'. *Academy of Management Review*, Vol. 19, No. 3, pp. 392-418.

Dedhia, N. S. (1995). 'Survive business challenges with the total quality management approach'. *Total Quality Management*, Vol. 6, No. 3, pp. 265-272.

Defeo, J. A. (1999). 'Six Sigma: road map for survival'. *HR Focus*, Vol. 76, No. 7, pp. 11-12.

DeFeo, J. A. (2000a). 'An ROI story: the black belt of Six Sigma'. *Training and Development*, Vol. 54, No. 7, pp. 25-27.

DeFeo, J. A. (2000b). 'Six Sigma: new opportunities for HR, new career growth for employees'. *Employment Relations Today*, Vol. 27, No. 2, pp. 1-7.

DeFeo, J. A. (2002). 'Creating strategic change more efficiently with a new design for Six Sigma process'. *Journal of Change Management*, Vol. 3, No. 1, pp. 60-81.

DeFeo, J. A. and Barnard, W. (2004a). *Juran Institute's Six Sigma*. New York: McGraw-Hill.

DeFeo, J. A. and Barnard, W. (2004b). *Six Sigma breakthrough and beyond*. Juran Institute. New York: McGraw-Hill.

DeJager, P. (2001). 'Resistance to change: a new view of an old problem'. *The Futurist*, Vol. 35, No. 3, pp. 24-27.

Del, J. (1998). 'Firms aim for Six Sigma efficiency'. *USA Today*. [online] Available: http://www.qualitytoday.com/library/sixsigma.htm [accessed 21/8/2008].

Dellana, S. A. and Hauser, R. D. (1999). 'Toward defining the quality culture'. *Engineering Management Journal*, Vol. 11, No. 2, pp. 11-15.

Delsanter, J. M. (1992). 'Six Sigma'. *Managing Service Quality*, Vol. 2, No. 4, pp. 203- 206.

DeMast, J. (2003). 'Quality improvement from the viewpoint of statistical method'. *Quality and Reliability Engineering International*, Vol. 19, No. 4, pp. 255-64.

Deming, W. E. (1950). *Some theory of sampling*. New York: Dover Publication.

Deming, W. E. (1986). *Out of crisis*. Cambridge: Massachusetts Institute of Technology. Centre for Advanced Engineering Study: Cambridge University.

Denison, D. R. and Mishra, A. K. (1995). 'Toward a theory of organizational culture and effectiveness'. *Organization Science*, Vol. 62, pp. 204-223.

Denscombe, M. (1998). *The good research guide for small-scale social research projects*. Buckingham: Open University Press.

Dent, E. and Goldberg, S. (1999). 'Challenging resistance to change'. *Journal of Applied Behavioural Science*, Vol. 35, No. 1, pp. 25-41.

Denton, D. K. (1991). 'Lessons on competitiveness: Motorola's approach'. *Production and Inventory Management Journal*, Vol. 32, No. 3, pp. 22-25.

Denzin, N. K. (1978). *The research act.* (2nd ed.). New York: McGraw Hill.

Denzin, N. K. and Lincoln, Y. S. (2000). *The handbook of qualitative research.* (2nd ed.). Thousand Oaks; London: Sage.

DeRuntz, B. and Meier, R. (2010). 'An evaluative approach to successfully implementing Six Sigma'. *Technology Interface Journal,* Spring Special, Vol. 10, No. 3, pp. 23-31.

Deshpande, D., Halder, S., Choudhary, A., Raychaudhuri, A. and Biswas, S. (2004). 'DMAIC approach brings breakthrough results'. *ASQ Six Sigma Forum Magazine,* Vol. 3, No. 2, pp. 24-29.

Deshpande, P. (1998). 'Emerging technologies and Six Sigma'. *Hydrocarbon Processing,* Vol. 77, No. 4, p. 55.

Deshpande, P., Makker, S. and Goldstein, M. (1999). 'Boost competitiveness via Six Sigma'. *Chemical Engineering Progress*, Vol. 95, No. 9, pp. 65-70.

Devane, R. (2004). *Integrating lean Six Sigma and high-performance organizations: Leading the charge toward dramatic, rapid and sustainable improvement.* San Francisco: Pfeiffer.

DeVaus, D. A. (1996). *Surveys in social research.* (4th ed.). London: UCL Press.

DeVaus, D. A. (2002). *Research design in social research.* London: UCL Press.

Dillman, D. A. (2000). *Mail and Internet Surveys: The Tailored Design Method.* New York: John Wiley.

Dirgo, R. (2006). *Look forward beyond lean and Six Sigma: a self-perpetuating enterprise improvement method.* Institute of Aerospace Excellence. Fort Lauderdale: J. Ross Publication.

Docherty, P. (2004). *Getting Six Sigma into the DNA of your organisation.* I-solutions White Paper.

Does, R., Van den Heuvel, E., DeMast, J. and Bisgaard, S. (2002). 'Comparing non-manufacturing with traditional applications of Six Sigma'. *Quality Engineering.* Vol. 15, No. 1, pp. 177-183.

Dornheim, M. (2001). 'Implement Six Sigma'. *Aviation Week and Space Technology*, Vol. 155, No. 1, p. 25.

Doss, D. A. and Kamery, R. H. (2006). 'A review of Six Sigma, international organisation for standardization (ISO) and the capability maturity model (CMM)'. *Proceedings of the Academy of Educational Leadership, Allied Academies International Conference,* pp. 119-123.

Douglas, P. C. and Erwin J. (2000). 'Six Sigma's focus on total customer satisfaction'. *Journal of Quality and Participation*, Vol. 23, No. 2, pp. 45-50.

Douglas, T. J. and Judge, W. Q. (2001). 'Total quality management implementation and competitive advantage: the role of structural control and exploration'. *Academy of Management Journal*, Vol. 44, No. 1, pp. 158-169.

Dreachslin, J. L. and Lee, P. D. (2007). 'Applying Six Sigma and DMAIC to diversity initiatives'. *Journal of Healthcare Management,* Vol. 52, No. 6, pp. 361-368.

Drickhamer, D. (2002). 'Where Lean meets Six Sigma'. *Industry Week*, Vol. 251, No. 4, pp.55.

Drucker, P. F. (1992). *Managing for the future: The 1990s and beyond.* New York: Truman Talley Books.

Dusharme, D. (2004). 'The foremost expert on Six Sigma talks about its past, present and future'. *Quality Digest* . Vol. 24, No. 2, pp. 69-73.

Smith, M., Lowe, A. and Thorpe, R. (2002). *Management research: an introduction.* London: Sage.

Easton, G. S. and Jarrell, S. L. (1998). 'The effects of total quality management on corporate performance: an empirical investigation'. *Journal of Business*, Vol. 71, No. 2, pp. 253-307.

Eckes, G. (2000). *The Six Sigma revolution.* New York: John Wiley.

Eckes, G. (2001a). *Making Six Sigma last: Managing the balance between cultural and technical change*. New York: John Wiley.

Eckes, G. (2001b). *The Six Sigma revolution: how General Electric and others turned process into profits*. New York: John Wiley.

Eckes, G. (2003a). *Six Sigma for everyone*. Hoboken, NJ: John Wiley.

Eckes, G. (2003b). *Six Sigma team dynamics: the elusive key to project success*. New York: John Wiley.

Eckes, G. (2005). *Six Sigma execution: how the world's greatest companies live and breathe Six Sigma.* New York; London: McGraw-Hill.

Edgeman, R. L., Bigio, D. and Ferleman, T. (2005). 'Six Sigma and business excellence: strategic and tactical examination of IT service level management at the office of the Chief Technology Officer of Washington, DC'. *Quality and Reliability Engineering International*, Vol. 21, No. 3, pp. 257-273.

Edson, J. and Zoyhofski, A. (1999). 'Testing needs change for Six Sigma processes', Quality, Vol. 38 No. 12, pp. 36.

Ehie, K. and Sheu, C. (2005). 'Integrating Six Sigma and theory of constraints for continuous improvement: a case study'. *Journal of Manufacturing Technology Management*, Vol. 16, No. 5, pp. 542-553.

Elliott, G. (2003). 'The race to Six Sigma'. *Industrial Engineer*, Vol. 35, No. 10, pp. 30-34.

Elliott, G. (2004). 'The journey to steps to Six Sigma'. *Handbook of Business Strategy*, pp. 201-205.

Ellis, K. (2001). 'Mastering Six Sigma'. *Training*, Vol. 28, No. 12, pp. 30-35.

Emory, C. W. (1985). *Business research methods*. Homewood: Irwin.

Emory, C. W. and Cooper, D. R. (1991). *Business research methods*. (4th ed.). Boston: Irwin.

Englund, R. and Müller, R. (2004). *Leading change towards enterprise project management, Projects and Profits*. ICFAI: University Press.

Erickson, T. J. (1992). 'Beyond TQM: creating the high performance business'. *Management Review*, Vol. 81, No. 7, pp. 58-60.

Erwin, J. (2000). 'It's not difficult to change company culture'. *Supervision*, Vol. 61, No. 11, pp. 6-11.

Evans, J. R. and Lindsay, W. M. (2005a). *An introduction to Six Sigma and process improvement*. Mason: Thomson/South-Western.

Evans, J. R. and Lindsay, W. M. (2005b). *The management and control of quality*. Mason: Thomson/South-Western.

Eye, A. V. and Schuster, C. (1998). *Regression analysis for social sciences*. London: Academic Press.

Fach, R. (2000). 'Six Sigma has its risks if not properly applied'. *Quality Progress*, Vol. 33, No. 1, pp. 13.

Faltin, D. M. and Faltin, F. W. (2003). 'Toe the line: no more worldcoms how Six Sigma metrics can reliably track an organization's financial results'. *Quality Progress*, , Vol. 36, No. 1, pp. 29-35.

Federico, M. and Beaty, R. (2003a). *Six Sigma team pocket guide*. New York: McGraw- Hill.

Federico, M. and Thomson, T. (2003b). *The role of human resources in Six Sigma*. [online] Available: http//www.isixsigma.com [accessed 21/07/2008].

Feigenbaum, A. V. (1991). *Total quality control*. (3rd ed.). New York: McGraw-Hill.

Feigenbaum, A. V. (1997). 'Changing concepts and management of quality worldwide'. *Quality Progress*. Vol. 30, No. 12, pp. 45-48.

Ferng, J. and Price, A. D. (2005). 'An exploration of the synergies between Six Sigma, total quality management, lean construction and sustainable construction'. *International Journal for Six Sigma and Competitive Advantage*, Vol. 1, No. 2, pp. 167-187.

Ferryanto, L. (2005). 'DFSS: lessons learned'. *ASQ Six Sigma Forum Magazine*, Vol. 4, No. 2, pp. 24-28.

Field, A. P. (2000). *Discovering statistics using SPSS for Windows: advanced techniques for the beginner*. London: Sage.

Feng, Q. M. and Manuel, C. M. (2008). 'Under the knife: a national survey of Six Sigma programs in US healthcare organizations'. *International Journal of Health Care Quality Assurance*, Vol. 21, No. 6, pp. 535-547.

Finn, G. (1999). 'Six Sigma quality for virtual products'. *Manufacturing Engineering*, Vol. 123, No. 6, pp. 20.

Flick, U. (2002). *An introduction to qualitative research*. London; Thousand Oaks: Sage.

Flynn, B. B. and Saladin, B. (2001). 'Further evidence on the validity of the theoretical models underlying the Baldrige criteria'. *Journal of Operations Management*, Vol. 19, pp. 617-652.

Flynn, B. B., Schroeder, R. G. And Sakakibara, S. (1995). 'The impact of quality management practices on performance and competitive advantage'. *Decision Sciences* Vol. 26, No. 5, pp. 659–692.

Folaron, J. (2003). 'The evolution of Six Sigma'. *ASQ Six Sigma Forum Magazine*, Vol. 2, No. 4, pp. 38-44.

Fontenot, G., Behara, R. and Gresham, A. (1994). 'Six Sigma in customer satisfaction'. *Quality Progress*, Vol. 27, No. 12, pp. 73-76.

Forza, C. and Filippini, R. (1998). 'TQM impact on quality conformance and customer satisfaction: a causal model'. *International Journal of Production Economics*, Vol. 55, pp. 1-20.

Foulkes, M. and Keight, E. (2002). 'Consumer-driven Six Sigma applied to HR at Ford Motor Co'. *Strategic HR Review*, Vol. 1, No. 2, pp. 26-30.

Fowler, F. J. (1998). Design and evaluation of survey question: Handbook of applied social research methods. London; Thousand Oaks: Sage.

Frank, S. (2003). 'Applying Six Sigma to revenue and pricing management'. *Journal of Revenue and Pricing Management*, Vol. 2, No. 3, pp. 245-254.

Frankfort-Nachmias, C. and Nachmias, D. (2000). *Research methods in the social sciences*. New York: Worth Publishers.

Freed, M. (1964). 'In quest of better questionnaires'. *Personnel and Guidance Journal*, Vol. 43, pp. 187-188.

Freiesleben, J. (2006). 'Insights from research communicating Six Sigma's benefits to top management'. *Measuring Business Excellence*, Vol. 10, No. 2, pp. 19-27.

Friberg, N. and Kowansky, E. (2006). *How not to implement Six Sigma: a manager's guide to ensuring the failure of the world's greatest quality improvement and waste reducing machine*. United States: Xlibris Corp.

Friday-Stroud, S. S. and Sutterfield, J. (2007). 'A conceptual framework for integrating Six Sigma and strategic management methodologies to quantify decision making'. *The TQM Magazine*, Vol. 19, No. 6, pp. 561-571.

Frings, G. W. and Grant, L. (2005). 'Who moved my sigma: effective implementation of Six Sigma methodology to hospitals?'. *Quality and Reliability Engineering International*, Vol. 21, No. 3, pp. 311-328.

Frost, M. (2003). 'Strategic Six Sigma'. *HR Magazine*, Vol. 48, No. 4, p. 125.

Fryer, K. J., Antony, J. and Douglas, A. (2007). 'Critical success factors of continuous improvement in the public sector: a literature review and some key findings'. *The TQM Magazine*, Vol. 19, No. 5, pp. 497-517.

Fuller, H. (2000). 'Observations about the success and evaluation of Six Sigma at Seagate'. *Quality Engineering*, Vol. 12, No. 3, pp. 311-315.

Fuller, N. (1998). 'Taguchi quality control'. *Supply Management*, Vol. 3, No. 2, p. 45.

Fuller, N. (1999). 'Quality management'. *Supply Management*, Vol. 4, No. 8, p. 43.

Gabor, A. (1990). *The man who discovered quality*. New York, NY: Natural House.

Gabor, A. (2001). *Management: Ford embraces Six Sigma. The New York Times*.

Gack, G. A. and Robison, K. (2003). 'Integrating improvement initiatives: connecting Six Sigma for software, CMMI, personal software process (PSP), and team software process (TSP)'. *ASQ Six Sigma Forum Magazine*, Vol. 5, No. 4, pp. 5-13.

Gaddam, L. R. and Amancha, S. (2005). 'Six Sigma in distance education: a roadmap for breakthrough'. *Proceeding ICDE International Conference*, November 19-23, New Delhi.

Garvin, D. A. (1987). 'Competing on the eight dimensions of quality'. *Harvard Business Review*, Vol. 65, No. 6, pp. 101-109.

Garvin, D. A. (1998). *Managing quality: the strategic and competitive edge*. New York: Free Press.

Garvin, D. A. (1991). 'How the Baldrige award really works'. *Harvard Business Review*, Vol. 69, No. 6, pp. 80-93.

Gatiss, G. F. (1996). *Total quality management: a total quality approach.* London: Cassell.

Gemeinhardt, G., Lemons, D., Breyfolgle, F. W. and Leavitt, P. (2001). *Deploying Six Sigma to bolster business processes and the bottom line*. Houston: American Productivity and Quality Centre.

General Electric (1997). *General Electric Company 1997 Annual Report*. [online] Available: http://www.ge.com/annual97 [accessed 21/4/2008].

General Electric (1999a). *GE 1999 Annual Report*. [online] Available: http://www.ge.com/annual99/letter/letter_three.html#sixsigma [accessed 21/4/2008].

General Electric. (1999b). What is Six Sigma? The roadmap to customer impact Six Sigma.

General Electric Company website (2004). [online] Available: http://www.ge.com [accessed 6/5/2008].

General Electric (2000). *Six Sigma and quality at GE.* [online] Available: http://www.ge.com/commitment/quality/whatis.htm [accessed 1/8/2008].

George, M. (2002). *Lean Six Sigma: combining Six Sigma quality with Lean speed.* New York, NY: McGraw-Hill.

George, M. L. (2003). *Lean Six Sigma for service: how to use Lean speed and Six Sigma quality to improve services and transactions*. New York: McGraw-Hill.

George, M. L., Maxey, J. W., Rowlands, D. T. and Upton, M. (2004). *The lean Six Sigma pocket tool-book: a quick reference guide to 100 tools for improving process quality, speed, and complexity*. New York; London: McGraw-Hill.

George, M. L., Rowlands, D. and Kastle, B. (2004). *What is Lean Six Sigma?*, New York: McGraw-Hill.

Ghauri, P. N., Kristianslund, I. and Gronhaug, K. (1995). *Research methods in business studies: a practical guide*. New York; London: Prentice-Hall International.

Gill, J. and Johnson, P. (2001). *Research methods for managers*. (3rd ed.). London: Sage.

Gitlow, H. S. and Levine, D. M. (2005). *Six Sigma for green belts and champions: foundations, DMAIC, tools, cases, and certification*. Upper Saddle River: Pearson/Prentice Hall.

Gitlow, H. S., Levine, D. M. and Popovich, E. A. (2006). *Design for Six Sigma for green belts and champions: applications for service operations foundations, tools, DMADV, cases, and certification*, Upper Saddle River; London: Pearson/Prentice Hall.

Glower, M. M. (2006). *Six Sigma: bringing it to your team. Nurse Leader*, April, pp.44-46.

Gnibus, R. J. (2000). 'Six Sigma's missing link - understanding the quality tool needed to calculate sigma ratings'. *Quality Progress*, Vol. 33, No. 11, pp. 77-81.

Gnibus, R. J. and Krull, R. (2003). 'Small companies see the money'. *Quality*, Vol. 42, No. 8, pp. 48-51.

Godfrey, A. E. (2002). 'Why Six Sigma?'. *Quality Progress*, Vol. 35, No. 1, pp. 6-7.

Goel, P. S. (2005). *Six Sigma for transactions and service*. New York: McGraw-Hill.

Goffnett, S. P. (2004). 'Understanding Six Sigma: implications for industry and education'. *Journal of Industrial Technology*, Vol. 20, No. 4. pp. 1-10.

Goh, P. L. and Ridgway, K. (1994). 'The implementation of total quality management in small and medium-sized manufacturing companies'. *The TQM Magazine*, Vol. 6, No. 2, pp. 54-60.

Goh, T. N. (2002a). 'A strategic assessment of Six Sigma'. *Quality and Reliability Engineering International*, Vol. 18, No. 5, pp. 403-410.

Goh, T. N. (2002b). 'The role of statistical design of experiments in Six Sigma: perspectives of a practitioner'. *Quality Engineering*, Vol. 14, No. 4, pp. 659-672.

Goh, T. N. and Xie, M. (2003). 'Statistical control of a Six Sigma process'. *Quality Engineering*, Vol. 15, No. 4, pp. 587-592.

Goh, T. N. and Xie, M. (2004). 'Improving on the Six Sigma paradigm'. *The TQM Magazine*, Vol. 16, No. 4, pp. 235-240.

Goldsby, T. J. and Martichenko, R. (2005). *Lean Six Sigma logistics: strategic development to operational success*. Boca Raton: J. Ross Publishing.

Goldstein, M. (2001). 'Six Sigma programme success factors'. *ASQ Six Sigma Forum Magazine*, Vol. 1, No. 1, pp. 36-45.

Goode, W. J. and Hatt, P. K. (1952). *Method in social research*. New York: McGraw-Hill.

Gordon, D. K. (2002). 'Quality management system vs. quality improvement'. *Quality Progress*, Vol. 35, No. 11, p. 86.

Gordon, J. (2002). *Six Sigma quality for business and manufacture*. Amsterdam; Boston: Elsevier.

Gowen, C. R. (2002). 'How to implement Six Sigma for maximum benefit'. *ASQ Six Sigma Forum Magazine*, Vol. 1, No. 2, pp. 27-31.

Grandzol, J. R. Gershon, M. (1997). 'Which TQM practices really matter: an empirical investigation?' *Quality Management Journal*. Vol. 4, No. 4, pp. 43-59.

Grant, M. M. (2006). 'Six Sigma for people? the heart of performance management'. *Human Resource Planning*, Vol. 29, No. 1, pp. 10-11.

Grant, R. M., Shani, R. and. Krishan, R. (1994). 'TQM's challenge to management theory and practice'. *Sloan Management Review*. Vol. 35, No. 2, pp. 25-35.

Graves, S. (2001). 'Six Sigma rolled throughput yield'. *Quality Engineering*, Vol. 14, No. 2, pp. 257-267.

Green, F. B. (2006). 'Six Sigma and the revival of TQM'. *Total Quality Management*, Vol. 17, No. 10, pp. 1281-1286.

Grim, S. (2001). 'Six Sigma business strategy aims at improving quality of care'. *Journal of Health Care Compliance*, Vol. 3, No. 3, pp. 73-75.

Gross, J. M. (2001). 'A road map to Six Sigma quality'. *Quality Progress*, Vol. 34, No. 11, pp. 24-30.

Gumani, H. (1999). 'Pitfalls in total quality management implementation: The case of a Hong Kong company'. *Total Quality Management*, Vol. 10, No. 2, pp. 209-228.

Gummesson, E. (2000). *Qualitative methods in management research*. London: Sage.

Gupta, B. C. and Walker, H. F. (2005). *Applied statistics for the Six Sigma green belt*. Milwaukee: ASQ Quality Press.

Gupta, B. C. and Walker, H. F. (2007). *Statistical quality control for the Six Sigma green belt*. Milwaukee: ASQ Quality Press.

Gupta, P. (2004). *Six Sigma business scorecard: ensuring performance for profit*. New York: McGraw-Hill.

Gupta, P. (2005). *The Six Sigma performance handbook: a statistical guide to optimizing results*. New York: McGraw-Hill.

Gupta, P. and Zawacki, J. (2002). 'Six Sigma deployment: who needs it?'. *Springs*, Vol. 2., pp. 15-19.

Gygi, C., Decarlo, N., Williams, B. and Covey, S. R (2005). *Six Sigma for dummies*, Hoboken: John Wiley.

Hackman, J. R., and Wageman, R. (1995). 'Total quality management: empirical, conceptual, and practical issues'. *Administrative Science Quarterly*, Vol. 40, pp. 309-342.

Hahn, G. J. (2005). 'Six Sigma: 20 key lessons learned'. *Quality and Reliability Engineering International*, Vol. 21, No. 3, pp. 225-233.

Hahn, G. J., Doganaksoy, N. and Hoerl, R. (2000). 'The evolution of Six Sigma'. *Quality Engineering*, Vol. 12, No. 3, pp. 317-326.

Hahn, G. J., Doganaksoy, N. and Stanard, C. (2001). 'Statistical tools for Six Sigma - What to emphasize and de-emphasize in training'. *Quality Progress*, Vol. 34, No. 9, pp. 78-82.

Haikonen, A., Savolainen, T. and Jarvinen, P. (2004). 'Exploring Six Sigma and CI capability development: preliminary case study findings on management role'. *Journal of Manufacturing Technology Management*, Vol. 15, No. 4, pp. 369-378.

Hakim, C. (2000). *Research design: successful designs for social and economic research.* London: Routledge.

Halliday, S. (2001). 'So what exactly is Six Sigma?' *Works Management*, Vol. 54, No. 1, p. 15.

Hamamoto, J. A. (2002). *The effects of Six Sigma implementation on transformational leadership skills.* DBA dissertation. Nova Southeastern University.

Hammer, M. (2002). 'Process management and the future of Six Sigma'. *IEEE Engineering Management Review*, Vol. 4, pp. 56-63.

Hammer, M. and Champy, J. (1995). *Business reengineering.* Frankfurt: Campus Verlag.

Hammer, M. and Goding, J. (2001). 'Putting Six Sigma in perspective'. *Quality*, Vol. 40, No. 10, pp. 58-62.

Hammersley, M. (1987). 'Some notes on the terms validity and reliability'. *British Educational Research Journal*, Vol. 13, No. 1, pp. 73-81.

Harari, O. (1993). 'Ten reasons why TQM doesn't work'. *Management Review*, Vol. 82, No. 1, pp. 33-38.

Hariharan, A. (2006). 'How to review Six Sigma projects'. *ASQ Six Sigma Forum Magazine*, Vol. 5, No. 3, pp. 18-19.

Hariharan, A. (2006). 'CEO's guide to Six Sigma success'. *ASQ Six Sigma Forum Magazine*, Vol. 5, No. 3, pp.20-25.

Harrington, S. H. (1992). *Business Process Improvement,* New York: McGraw Hill.

Harrold, D. and Bartos, F. (1999). 'Optimize existing processes to achieve Six Sigma capability'. *Control Engineering*, Vol. 46, No. 3, pp. 87-103.

Harry, M. J. (1994). *The vision of Six Sigma: A roadmap for breakthrough.* Phoenix: Sigma Publishing Company.

Harry, M. J. (1997a). *The nature of Six Sigma quality.* Schaumburg, IL: Motorola University Press.

Harry, M. J. (1997b). *The vision of Six Sigma* (5th ed.). Phoenix: Tri Star.

Harry, M. J. (1998). 'Six Sigma: a breakthrough strategy for profitability'. *Quality Progress,* Vol. 31, No. 5, pp. 60-65.

Harry, M. J. (2000a). 'Abatement of business risk is key to Six Sigma'. *Quality Progress,* Vol. 33, No. 7, pp. 72-76.

Harry, M. J. (2000b). 'Six Sigma leads enterprises to coordinate efforts'. *Quality Progress,* Vol. 33, No. 3, pp. 70-73.

Harry, M. J. (2000c). 'Six Sigma focuses on improvement rates'. *Quality Progress*, Vol. 33, No. 6, pp. 76-81.

Harry, M. J. and Lawson, J. R. (1992). *Six Sigma productability analyses and process characterization.* Reading; Wokingham: Addison-Wesley.

Harry, M. J. and Linsenmann, D. R. (2006). *The Six Sigma fieldbook: how Dupont successfully implemented the Six Sigma breakthrough management strategy.* New York: Currency/Doubleday.

Harry, M. J. and Schroeder, R. (2000). *Six Sigma: the breakthrough management strategy revolutionizing the world's top corporations.* New York: Currency Doubleday.

Hayler, R. and Nichols, M. (2005). *What is Six Sigma process management?.* New York: McGraw-Hill.

Hayler, R. and Nichols, M. (2007). *Six Sigma for financial services.* New York: McGraw-Hill.

Hearing, L. (2004). 'Six Sigma insight'. *HR Magazine*, Vol. 49, No. 3, pp. 76-80.

Henderson, K. M. and Evans, J. R. (2000). 'Successful implementation of Six Sigma: benchmarking General Electric company'. *Benchmarking: an International Journal,* Vol. 7, No. 4, pp. 260-281.

Hendricks, C. A. and Kelbaugh, R. L. (1998). 'Implementing Six Sigma at GE'. *The Journal for Quality and Participation*, Vol. 21, No. 4, pp. 48-53.

Hendricks, C. F. and Triplett, A. (1989). 'TQM: strategy for 90s management'. *Personnel Administrator*, Vol. 34, No. 12, pp. 42-48.

Hendricks, K. B., and Singhal, V. R. (1997). 'Does implementing an effective TQM programme actually improve operating performance? Empirical evidence from firms that have won quality awards'. *Management Science*, Vol. 43, No. 5, pp. 1258-1274.

Hendry, L. (2005). *Exploring the Six Sigma phenomenon using multiple case study evidence.* Lancaster University Management School Working Paper 2005/056.

Hendry, L. and Nonthaleerak, P. (2005). *Six Sigma: literature review and key future research areas*. Lancaster University Management School Working Paper 2005/044.

Henretta, K., Walker, J. and Bellafiore, L. (2003). 'Applying Six Sigma to chromatography: Cutting costs through process improvements'. *Genetic Engineering News*, Vol. 23, No. 1, pp. 54-56.

Hensley, R. L. and Dobie, K. (2005). 'Assessing readiness for Six Sigma in a service setting'. *Managing Service Quality*, Vol. 15, No. 1, pp. 82-101.

Heuvel, J., Does, R. and Bisgaard, S. (2005). 'Dutch hospital implements Six Sigma'. *ASQ Six Sigma Forum Magazine*, Vol. 4, No. 2, pp. 11-14.

Heuvel, J., Does, R. J. and Verver, J. P. (2005). 'Six Sigma in healthcare: lessons learned from a hospital'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 4, pp. 380-388.

Hild, C., Sanders, D. and Cooper, T. (2000). 'Six Sigma on continuous processes: how and why it differs'. *Quality Engineering*, Vol. 13, No. 1, pp. 1-9.

Hilliday, S. (2001). *So what is exactly.... Six Sigma?* Horton Kirby: Works Management.

Ho, L. H. and Chuang, C. C. (2006). 'A study of implementing Six Sigma quality management system in government'. *Journal of American Academy of Business*, Vol. 10, No. 1, pp. 167-173.

Hoerl, R. W. (1998a). 'Six Sigma and the future of the quality profession', *IEEE Engineering Management Review*, Vol. 26, No. 3, pp. 87-94.

Hoerl, R. W. (1998b). 'The fundamentals of Six Sigma'. *Quality Progress*, Vol. 31, No. 6, pp. 36-38.

Horel, R W. (2001). 'Six Sigma black belts: What do they need to know?'. *Journal of Quality Technology,* Vol. 33, No. 4, pp. 391-435.

Hoerl, R. W. (2004a). 'One perspective on the future of Six Sigma'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 112-119.

Hoerl, R. W. (2004b). 'The future of Six Sigma'. *ASQ Six Sigma Forum Magazine*, Vol. 8., No. 4, pp.38-43.

Hoerl, R. W. and Bryce, G. R. (2004). 'What influence is the Six Sigma movement having in universities? What influence should it be having?'. *ASQ Six Sigma Forum Magazine*, Vol. 3, No. 2, pp. 37-40.

Hoerl, R. W. and Snee, R. D. (2003). *Leading Six Sigma: a step-by-step guide based on experience with GE and other Six Sigma companies*. New Jersey: Financial Times, Prentice Hall.

Holtz, R. and Campbell, P. (2004). 'Six Sigma: its implementation in Ford's facility management and maintenance function'. *Journal of Facilities Management*, Vol. 2, No. 4, pp. 320-329.

Honeywell Company website (2004). <www.honeywell.com> [accessed 9/11/2008].

Hong, G. Y. and Goh, T. N. (2003). 'Six Sigma in software quality'. *The TQM Magazine*, Vol. 15, No. 6, pp. 364-373.

Hong, G. Y. and Goh, T. N. (2004). 'A comparison of Six Sigma and GQM approaches in software development'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 65-75.

Hopen, D. (2003). 'The softer side of Six Sigma'. *ASQ Six Sigma Forum Magazine*, Vol. 2, No. 2, p. 8.

Hoque, M., Akter, M. and Hossain, D. M. (2006). 'Six Sigma and total quality management: a comparison'. *The Cost and Management*, Vol. 34, No. 2, pp. 5-18.

Horst, R. (1999). 'Safety and Six Sigma'. *Manufacturing Engineering*, Vol. 122, No. 2, p. 14.

Hsieh, C. T., Lin, B. and Manduca, B. (2007). 'Information Technology and Six Sigma implementation'. *The Journal of Computer Information Systems*, Vol. 47, No. 4, pp. 1-10.

Huberman, A. M. and Miles, M. B. (2002). *The qualitative researcher's companion.* Thousand Oaks; London: Sage.

Hunter, D. (1999). 'Six Sigma steps'. *Chemical Week*, Vol. 161, No. 33, p. 3.

Hunter, D. and Schmitt, B. (1999). 'Six Sigma: benefits and approaches'. *Chemical Week*, Vol. 61, No. 37, pp. 35-36.

Hussey, J. and Hussey, R. (2003). *Business research: a practical guide to undergraduate and postgraduate students.* Basingstoke: Palgrave Macmillan.

Hutchins, D. (2000). 'The power of Six Sigma in practice'. *Measuring Business Excellence*, Vol. 4, No. 2, pp. 26-33.

Hutchins, G. (2000). 'The branding of Six Sigma'. *Quality Progress*, Vol. 33, No. 9, pp. 120-122.

Hyde, A. C. (2000). 'Six Sigma black belt'. *Public Manager*, Vol. 28, No. 4, pp. 57-60.

Ingle, S. and Roe, W. (2001). 'Six Sigma: black belt implementation'. *The TQM Magazine*, Vol. 13, No. 4, pp. 273-280.

Ingle, S. and Roe, W. (2002). 'Black Belts save Motorola a billion'. *Strategic Direction*, Vol. 18, No. 1, pp. 8-13.

Ipolito, P. A. (2000). 'Six Sigma lacks breakthrough thinking'. *Quality Progress*, Vol. 33, No. 1, p. 13.

Irani, Z., Beskese, A. and Love, P. D. (2004). 'Total quality management and corporate culture: constructs of organizational excellence'. *Technovation*, Vol. 24, pp. 643-650.

Ishikawa, K. (1985). *What Is Total Quality Control? The Japanese Way.* Englewood Cliffs, NJ: Prentice-Hall.

Jarrar, Y. and Neely, A. (2003). Six Sigma - friend or foe? [online] Available: http://www.onesixsigma.com [accessed 05/1/2008].

Jeffery, A. B. (2005). 'Integrating organization development and Six Sigma: Six Sigma as a process improvement'. *Organization Development Journal*, Vol. 23, No. 4, pp. 20-31.

Jenicke, L. O., Kumar, A. and Holmes, M. C. (2008). 'A framework for applying Six Sigma improvement methodology in an academic environment'. *The TQM Journal*, Vol. 20, No. 5, pp. 453-462.

Jick, T. (1979). 'Mixing qualitative and quantitative methods: triangulation in action'. *Administrative Science Quarterly*, Vol. 24, No. 4, pp. 602-611.

Jick, T. and Peiperl, M. A. (2003). *Managing change: cases and concepts.* New York: McGraw-Hill Higher Education.

Jing, G. G. and Li, N. (2004). 'Claiming Six Sigma'. *Industrial Engineer*, Vol. 36, No. 2, pp. 37-39.

Joglekar, A. M. (2003). *Statistical methods for Six Sigma: in RandD and manufacturing.* Hoboken: Wiley-Interscience.

Johannsen, F. and Leist, S. (2009). 'A Six Sigma approach for integrated solutions'. *Managing Service Quality*, Vol. 19, No. 5, pp. 558-580.

Johnson, A. (2002). 'Six Sigma in RandD'. *Research technology management*, Vol. 45, No. 2, pp. 12-17.

Johnson A. and Swisher. B. (2003). 'Now Six Sigma improves RandD'. *Research Technology Management*, Vol. 46, No. 2, pp. 12-15.

Johnson, R. A. and Wichern, D. W. (1998). *Applied multivariate statistical analysis.* (4th ed.). Upper Saddle River; London: Prentice-Hall International.

Johnston, C. and Daniel, M. (1991). 'Customer satisfaction through quality'. *Canadian Business Review*, Winter, pp. 12-15.

Johnston, D. (2003). 'Six Sigma demystified'. *Cleanroom Technology*, Vol. 9, No. 9, pp. 35-36.

Jones, S. H. (2006). 'To use DMEDI or to use DMAIC? That is the question'. [online]. Available: http://www.isixsigma.com/library/content [accessed 14/08/2008].

Joyce, L. (2004). 'Six Sigma add-ons help companies make the leap'. *R and D*, Vol. 46, No. 1, pp. 36-38.

Juran Institute (2001). *The Six Sigma basic training kit*. New York: McGraw-Hill.

Juran J. M. and Godfrey, A. B. (1999). *Juran's quality handbook*. (5th ed.). New York: McGraw-Hill.

Juran, J. and Gryna, F. (1980). *Quality planning and analysis*. New York: McGraw-Hill.

Juran, J. M. (1988a). *Juran on planning for quality*, New York: Free Press.

Juran, J. M. (1988b). *Quality control handbook*. New York: McGraw Hill.

Juran, J. M. (1989). *Juran on leadership for quality: An executive handbook*. New York: free Press.

Juran, J. M. (1992). *Juran on quality by design*. New York: Free Press.

Juran, J. M. (1995). *A history of managing for quality*. Milwaukee: ASQC Quality Press.

Justiniano, J. M. and Gopalaswamy, V. (2005). *Six Sigma for medical device design*. Boca Raton: CRC Press.

Kane, L. (1998). 'The quest for Six Sigma'. *Hydrocarbom Processing*, Vol. 77, No. 2, p. 15.

Kane, V. E. (1989). *Defect Prevention*. Marcel Dekker, Inc. ASQC Quality Press.

Kanji, G. K. and Barker, R. L. (1990). 'Implementation of total quality management'. *Total Quality Management*, Vol. 1, No. 3, pp. 375-389.

Kanji, G. K. and Asher, M. (1993). *Total quality management process: A systematic approach, advances in total quality management series*, Carfax, Abingdon.

Kaplan, R. S. and Norton, D. P. (1992). 'The balanced scorecard - measures that drive performance'. *Harvard Business Review*, Vol. 70, No. 1, pp.71-79.

Kaplan, R. S. and Norton, D. P. (1993). 'Putting the balanced scorecard to work'. *Harvard Business Review*, Vol. 71, No. 5, pp.138-140.

Kaufmann, U. H. (2000). Implementing Six Sigma. *Quality Digest*. [online] Available: http://www.qualitydigest.com/augOO/html/lastword.html [accessed 20/12/2008].

Kazmer, D., Hatch, D. and Zhu, L. (2002). 'Investigation of variation and uncertainty in Six Sigma'. *Proceedings of ASME Design Engineering Technical Conference*, Vol. 3, pp. 21-29.

Keim, E., Fox, L. and Mazza, J. S. (2001). 'Service quality Six Sigma case studies', *ASQ Annual Quality Congress Proceedings*. Milwaukee, pp. 188-193.

Keller, P. A. (2001). 'Recent trends in Six Sigma'. *ASQ Annual Quality Congress Proceedings*, Milwaukee, pp. 98-102.

Keller, P. A. (2001). *Six Sigma deployment: a guide for implementing Six Sigma in your Organisation*. Tucson: Quality Publishing.

Keller, P. A. (2005). *Does Six Sigma work in Smaller Companies?* http://www.qualityamerica.com/knowledgecente/articles/.htm [accessed 24/7/2009]

Kelly, W. M. (2002). 'Three steps to project selection'. *ASQ Six Sigma Forum Magazine*, Vol. 2, No. 1, pp. 29-32.

Kendall, J. and Fulenwider, D. O. (2000). 'Six Sigma, e-commerce pose new challenges'. *Quality Progress*, Vol. 33, No. 7, pp. 31-38.

Kilbey, G. (2003). 'Six Sigma'. *BFS*, Vol. 117, No. 4, pp.18-20.

King, R. (2003). 'Six Sigma and its application in healthcare', *ASQ Annual Quality Congress Proceedings*, Milwaukee, pp. 39-46.

Kinnear, P. R. and Gray, C. D. (1999). *SPSS for Windows made simple*. (3rd ed.). Padstow: Psychology Press.

Kirk, J. and Miller, M. L. (1986). *Reliability and validity in qualitative research*. Beverly Hills: Sage.

Kleasen, K. (2007). 'Building human resources strategic planning, process and measurement capability: using Six Sigma as a foundation'. *Organization Development Journal*, Vol. 25, No. 2, pp. 37-41.

Klefsjoe, B., Wiklund, H. and Edgeman, R. (2001). 'Six Sigma seen as a methodology for total quality management'. *Measuring Business Excellence*, Vol. 5, No. 1, pp. 31-35.

Kline, R. B. (1998). *Principles and practices of structural equation modelling.* New York: Guilford.

Knowles, G., Johnson, M. and Warwood, S. (2004). 'Medicated sweet variability: a Six Sigma application at a UK food manufacturer'. *The TQM Magazine*, Vol. 16, No. 4, pp. 284-292.

Kodak (2005). *Kodak Six Sigma Black Belt.* [online] Available: http//www.kodak.com/US/researchdevelopment/careers/SixSigma.html [accessed 3/10/2008].

Koning, H. D. and Mast, J. D. (2006). 'A rational reconstruction of Six Sigma's breakthrough cookbook'. *International Journal of Quality and Reliability Management*, Vol. 23, No. 7, pp. 766-787.

Koning, H. D., Verver, J. P., Heuvel, J. V., Bisgaard, S. and Does, R. M. (2006). 'Lean Six Sigma in healthcare'. *Journal for Healthcare Quality*, Vol. 28, No. 2, pp. 4-11.

Koons, G. (1992). *Indices of capability: classical and Six Sigma tools.* Reading: Addison-Wesley.

Kooy, M. and Pexton, C. (2000). 'Using Six Sigma to improve clinical quality and outcomes' [online] Available: http://healthcare.isixsigma.com/library [accessed 17/7/2008].

Kubiak, T. (2004). 'What does it take to be a master black belt?'. *ASQ Six Sigma Forum Magazine*, Vol. 3, No. 2, pp. 40-41.

Kuei, C. H. and Madu, C. N. (2003). 'Customer-centric Six Sigma quality and reliability management'. *The International Journal of Quality and Reliability Management*, Vol. 20, No. 8, pp. 954-964.

Kumar, D. (2006a). *Reliability and Six Sigma.* New York: Springer Science Business Media.

Kumar, D. (2006b). *Six Sigma best practices: a guide to business process excellence for diverse industries.* Lauderdale: J. Ross Publishing.

Kumar, M. (2007). 'Success Factors and Hurdles to Six Sigma Implementation: the case of a UK manufacturing SME'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 3, No. 4, pp. 333-351.

Kumar, M. and Antony, J. (2008). 'Comparing the quality management practices in UK SMEs'. *Industrial Management and Data Systems*, Vol. 108, No. 9, pp. 1153-1166.

Kumar, M., Antony, J. and Cho, B. R. (2009). 'Project selection and its impact on the successful deployment of Six Sigma'. *Business Process Management Journal*, Vol. 15, No. 5, pp. 669-686.

Kumar, M., Antony, J., Hari, S., Wang, C., (2006). 'Evaluating the relationship between Six Sigma and Organisational Performance: A Case Study from a UK SME'. *British Academy of Management Conference*, 12^{th}-14^{th} September, Belfast, UK.

Kumar, M., Antony, J., Madu, C. N., Montgomery, D. C. and Park, S. H. (2008). 'Common myths of Six Sigma demystified'. *International Journal of Quality and Reliability Management*. Vol. 25, No. 8, pp. 878-895.

Kumar, M., Antony, J., Singh, R. K., Tiwari, M. K. and Perry, D. (2006). 'Implementing the Lean Sigma Framework in an Indian SME: A Case Study'. *Production Planning and Control*, Vol. 17, No. 4, pp. 407-423.

Kumar, S. and Gupta, Y. (1993). 'Statistical process control at Motorola's Austin assembly plant'. *Interface*, Vol. 23, No. 2, pp. 84-92.

Kumar, S., Wolfe, A. D. and Wolfe, K. A. (2008). 'Using Six Sigma DMAIC to improve credit initiation process in a financial services operation'. *International Journal of Productivity and Performance Management*, Vol. 57, No. 8, pp. 659-676.

Kumar, V., Choisne, F., Grosbois, D. and Kumar, U. (2009). 'Impact of TQM on company's performance'. *International Journal of Quality and Reliability Management*, Vol. 26, No. 1, pp. 23-37.

Kumar, U. D., Saranga, H., Ramirez-Marquez, J. E. and Nowicki, D. (2007). 'Six Sigma project selection using data envelopment analyses'. *The TQM Magazine*, Vol. 19, No. 5, pp. 419-441.

Kumar, M., Upadhyay, S., Ogbu, C., Antony, J. (2008). 'An investigation of Six Sigma implementation within UK manufacturing SMEs: Findings from the survey'. *First European Research Conference on Continuous Improvement and Lean Six Sigma*, 10 March, 2008, University of Strathclyde, Glasgow.

Kumi, S. and Morrow, J. (2006). 'Improving self-service the Six Sigma way at Newcastle University Library'. *Electronic Library and Information Systems*, Vol. 40, No. 2, pp. 123-136.

Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing*. London: Sage.

Kwak, Y. H. and Anbari, F. T. (2006). 'Benefits, challenges and future of Six Sigma approach'. *Technovation*, Vol. 26, No. 5-6, pp. 708-715.

Lakhavani, S. T. (2003). 'Six Sigma implementation: trials, tribulations and lessons learned', *ASQ Annual Quality Congress Proceedings*. Milwaukee, Vol. 57, pp. 643-647.

Larson, A. (2003). *Demystifying Six Sigma: a company-wide approach to continuous improvement*. New York: AMACOM.

Lawrence, P. R. (1991). *How to deal with resistance to change*. Boston: Harvard Business School Press.

Lawton, R. (2006). '8 dimensions of Excellence'. *Quality Progress*, Vol. 39, No. 4, pp. 55-62.

Lazarus, I. and Butler, K. (2001). 'The promise of Six Sigma (Part1)'. *Managed Healthcare Executive*, Vol. 11, No. 9, pp. 22-6.

Lazarus, I. and Stamps, B. (2002). 'The promise of Six Sigma (Part 2)', *Managed Healthcare Executive*, Vol. 12, No. 1, pp. 27-30.

Lazarus, I. and Novicoff, W. (2004). 'Six Sigma enters the health care mainstream'. *Managed Healthcare Executive*, Vol. 14, No. 1, pp. 26-29.

Leavitt, P. (2002). *Lessons Learned in Six Sigma Implementation*. American Productivity Quality Center (APQC).

Lee, J. (1992). 'Qualitative versus qualitative research methods: two approaches to organizational studies'. *Asia Pacific Journal of Management*, Vol. 9, No. 1, pp. 87-94.

Lee, K. (2002). *Critical success factors of Six Sigma implementation and the impact on operations performance*. PhD. Dissertation, Cleveland State University.

Lee, K. C. and Choi, B. (2006). 'Six Sigma management activities and their influence on corporate competitiveness'. *Total Quality Management*, Vol. 17, No. 7, pp. 893-911.

Lee-Mortimer, A. (2006a). 'Six Sigma: a vital improvement approach when applied to the right problems, in the right environment'. *Assembly Automation*, Vol. 26, No. 1, pp. 10-17.

Lee-Mortimer, A. (2006b). 'Six Sigma: effective handling of deep rooted quality problems'. *Assembly Automation*, Vol. 26, No. 3, pp. 200-204.

Levine, D. M. (2006). *Statistics for Six Sigma green belts*. Upper Saddle River: Pearson Prentice Hall.

Levy, P. S. and Lemeshow, S. (1991). *Sampling of populations*. New York: John Wiley.

LG Electronics (2002). *Six Sigma enables LG Electronics to improve business performance*. Explanatory paper. LG Electronics/Digital Appliance Company.

Lientz, B. P. and Rea, K. P. (2002). *Achieve lasting process improvement: reach Six Sigma goals without the pain*. San Diego: Academic Press.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*.

Linderman, K., Schroeder, R. G., Zaheer, S. and Choo, A. S. (2003). 'Six Sigma: a goal-theoretic perspective'. *Journal of Operations Management*, Vol. 21, pp. 193- 203.

Little, B. (2003). 'Six Sigma techniques improve the quality of e-learning'. *Industrial and Commercial Training*, Vol. 35, No. 3, pp. 104-108.

Llorens-Montes, F. J. and Molina, L. M. (2006). 'Six Sigma and management theory: processes, content and effectiveness'. *Total Quality Management,* Vol. 17, No. 4, pp. 485-506.

Lo, W. K. (1997). 'Application of Deming's principles in the management of change: a Hong Kong experience'. *The TQM Magazine*, Vol. 9, No. 5, pp. 336-343.

Lowenthal, J. N. (2000). *'Six Sigma: a black belts' guide to implementing a Six Sigma project*, West Bloomfield: Vision-IBS, Ltd.

Lowenthal, J. N. (2001). *Six Sigma project management: a pocket guide.* Milwaukee: ASQ Quality Press.

Lowenthal, J. N. (2003). *Defining and analyzing a business process: a Six Sigma pocket guide.* Milwaukee: ASQ Quality Press.

Lucas, J. (2002). 'The essential Six Sigma. How successful Six Sigma implementation can improve the bottom line'. *Quality Progress*, Vol. 1, No. 35, Jan., pp. 27-31.

Lucier, G. T. and Seshadri, S. (2001). 'GE takes Six Sigma beyond the bottom line'. *Strategic Finance*, Vol. 82, No. 11, pp. 41-46.

Lynch, D. P. and Elaine, T. C. (2003). 'Five steps to success'. *Six Sigma Forum Magazine*, Vol. 2, No. 2, pp. 27-33.

Lynch, D. P., Bertolino, S. and Cloutier, E. (2003). 'How to scope DMAIC projects'. *Quality Progress*, Vol. 36, No. 1, pp. 37-41.

Maguire, M. (1999). 'Six Sigma'. *Quality Progress*, Vol. 32, No. 10, pp. 6.

Mahanti, R. and Antony, J. (2005). 'Confluence of Six Sigma, simulation and software development'. *Managerial Auditing Journal*, Vol. 20, No. 7, pp. 739-762.

Mahoney, F. X. and Thor, C. G. (1994). *The TQM trilogy: using ISO 9000, the Deming prize, and the Baldrige award to establish a system for total quality management.* New York: AMACOM.

Maleyeff, J. and Krayenvenger, D. E. (2004). 'Goal setting with Six Sigma mean shift determination'. *Aircraft Engineering and Aerospace Technology*, Vol. 76, No. 6, pp. 577.

Man, J. (2002). 'Six Sigma and lifelong learning'. *Work Study*, Vol. 51, No. 4, pp. 197-201.

Mann, N. R. (1989). *The keys to excellence.* New York: McGraw Hill.

Mann, R. and Kehoe, D. (1995). 'Factors affecting the implementation and success of TQM'. *International Journal of Quality and Reliability Management*, Vol. 12, No. 1, pp. 11-23.

Manuela, P. D. and Fuetnes, C. M. (2003). 'Resistance to change: a literature review and empirical study'. *Management Decision*, Vol. 41, No. 2, pp. 148-155.

Marash, S. A. (2000). 'Six Sigma: business results through innovation'. *Annual ASQ Quality Congress Proceedings*, Milwaukee, pp. 627-630.

Marx, M. (2007). 'Six Sigma saves a fortune'. *iSixSigma Magazine*, Vol. 3, No. 1, pp. 23-26.

Mast, J. D. (2006). 'Six Sigma and competitive advantage'. *Total Quality Management*, Vol. 17, No. 4, pp. 455-464.

Maxim, P. S. (1999). *Quantitative research methods in social sciences.* Oxford: Oxford University Press.

May, T. (1997). *Social research: issues, methods and process.* (2nd ed.). Buckingham: Open University Press.

McAdam, R. and Evans, A. (2004a). 'Challenges to Six Sigma in a high technology mass-manufacturing environments'. *Total Quality Management*, Vol. 15, No. 5, pp. 699-706.

McAdam, R. and Evans, A. (2004b). 'The organisational contextual factors affecting the implementation of Six Sigma in a high technology mass-manufacturing environment'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 29-43.

McAdam, R. and Lafferty, B. (2004). 'A multilevel case study critique of Six Sigma; statistical control or strategic change?'. *International Journal of Operations and Production Management*, Vol. 24, No. 5, pp. 530-549.

McAdam, R., Hazlett, S. A. and Henderson, J. (2005). 'A critical review of Six Sigma: exploring the dichotomies'. *International Journal of Organizational Analysis*, Vol. 13, No. 2, pp. 151-174.

McCarty, T. (2005). *The Six Sigma black belt handbook*. New York: McGraw-Hill.

McCarty, T. D and Fisher, S. A. (2007). 'Six sigma: it is not what you think'. *Journal of Corporate Real Estate*, Vol. 9, No. 3, pp. 187-196.

McClusky, R. (2000). 'The rise, fall and revival of Six Sigma'. *Measuring Business Excellence*, Vol. 4, No. 2, pp. 6-17.

McDaniel, C. and Gates, R. (2002). *Marketing research*. (5th ed.), Cincinnati: South-Western.

McFadden, F. R. (1993). 'Six Sigma quality programmes'. *Quality Progress*, Vol. 26, No. 6, pp. 37-42.

McIlroy, J. and Silverstein, D. (2001). 'Six Sigma deployment in one aerospace company', *ASQ Annual Quality Congress Proceedings*. Milwaukee, pp. 103-109.

Means, J. and Adams, T. (2005). *Facilitating the project lifecycle: the skills and tools to accelerate progress for Six Sigma and project teams*. San Francisco: Jossey-Bass.

Measuring Business Excellence (2002). 'GE and Motorola belt up for Six Sigma success'. *Measuring Business Excellence*, Vol. 6, No. 3, pp. 64-67.

Mellat-Parast, M., Jones, E. C. and Adams, S. G. (2007). 'Six Sigma and Baldrige: a quality alliance'. *Quality Progress*, Vol. 40, No. 9, pp. 45-51.

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.

Merton, R. K. (1968). *Social theory and social structure*. New York: Free Press.

Michael, S. (2005). 'Feds train to achieve Six Sigma results'. *Federal Computer Week*, Vol. 19, No. 34, pp. 42-43.

Michael, S. and Beck, L. (1995). *Data analysis, an introduction*. London: Sage.

Michalski, W. J. and Michalski, W. J. (2003). *Six Sigma tool navigator: the master guide for teams*. New York: Productivity Press.

Miles, M. B. and Huberman, A. M. (1994). *Qualitative data analysis: an expanded sourcebook*. (2nd ed.). London: Sage.

Miller, L. M. and Brewer, J. D. (2003). *The A-Z of social research*. London: Sage.

Miller, M. J. and Ferrin, D. M. (2005). 'The application of simulation methodology in a hospital's Six Sigma project'. *Proceedings of Winter Simulation Conference*, pp. 2016-2019.

Milosavljević, P. and Rall, K. (2005). 'Six Sigma concept in the maintenance process of technical systems'. *Mechanical Engineering*, Vol. 3, No. 1, pp. 93-108.

Milton, J. S. and Arnold, J. C. (1995). *Introduction to probability and statistics: principles and applications for engineering and computing science*. Dubuque: McGraw-Hill.

Mitra, A. (2004). 'Six Sigma education: a critical role for academia'. *The TQM Magazine*, Vol. 16, No. 4, pp. 293-302.

Modaress, B. and Aussari, M. (1989). 'Quality control techniques in US firms: a survey'. *Production and Inventory Management Journal*, 2nd quarter.

Montgomery, D. (2001). 'Beyond Six Sigma'. *Quality and Reliability Engineering International*, Vol. 17, No. 3, pp. iii-iv.

Montgomery, D. C. (2000). *Introduction to statistical quality control*. (4th ed.). New York: John Wiley.

Montgomery, D. C., Lawson, C. and Molnau, W. E. (2001). 'Six Sigma Black Belts: What do they need to know?' *Journal of Quality Technology*, Vol. 33, No. 4, pp. 407-409.

Moore, K. G. (2002). 'Six Sigma: driving supply chain success at Ford', *Supply Chain Management Review*, July/August, pp. 38-43.

Moorman, D. W. (2005). 'On the quest for Six Sigma'. *The American Journal of Surgery*, Vol. 189, pp. 253-258.

Morgan, J. (2005). 'Six Sigma - the route to business excellence'. *Management Services*, Vol. 49, No. 4, pp. 32-33.

Morgan, J. (2006). 'Follow me; I'm right behind you on this Six Sigma thing'. *Management Services*, Vol. 50, No. 1, pp. 29-30.

Morris, S. and Haigh, H. (1996). *Overcoming the barriers to TQM.* London: Chapman and Hall.

Morris, T. and Wood, S. (1991). 'Testing the survey method: continuity and change in British industrial relations'. *Work Employment and Society*, Vol. 5, No. 2, pp. 259-282.

Morrow, C. C., Jarrett, M. Q., Rupinski, M. T. (1997). 'An investigation of the effect and economic utility of corporate wide training'. *Personnel Psychology*, Vol. 50, pp. 91-119.

Moser, C. S. and Kalton, G. (2001). *Survey methods in social investigation.* Aldershot: Dartmouth Publishing.

Motorola Company website (2004). [online] Available: http://www.motorola.com [accessed 5/1/2009].

Motorola University (2005). What is Six Sigma? [online] Available: http://www.motorola.com/content/03088,00.html. [accessed 25/1/2009].

Motwani, J. (2001). 'Critical factors and performance measures of TQM'. *The TQM Magazine*, Vol. 13, No. 4, pp. 292-300.

Motwani, J., Kumar, A. and Antony, J. (2004). 'A business process change framework for examining the implementation of Six Sigma: a case study of Dow Chemicals'. *The TQM Magazine*, Vol. 16, No. 4, pp. 273-283.

Mukesh, D. (2003). 'Putting Six Sigma processes to work'. *Chemical Engineering*, Vol. 110, No. 12, p. 62.

Munro, R. A. (2000). 'Integrating Six Sigma with QS-9000: auto industry adds new tool for quality improvement'. *Quality Progress*, Vol. 33, No. 5, pp. 47-54.

Munro, R. A. (2003). *Six Sigma for the office: a pocket guide.* Milwaukee: ASQ Quality Press.

Murphy, T. (1998). 'Close enough for perfect in the push for quality: Six Sigma leaves no stone unturne'. *Ward's Auto World*, Vol. 34, No. 8, pp. 36-42.

Murugappan, M. and Keeni, G. (2003). 'Blending CMM and Six Sigma to meet business goals'. *IEEE Software*, Vol. 20, No. 2, pp. 42-48.

Myers, K. (2001). 'The concept and use of defect opportunity in Six Sigma quality'. *Quality Technologies*. Vol. 2, No. 2, pp. 23-26.

Nabhani, F. and Shokri, A. (2009). 'Reducing the delivery lead time in a food distribution SME through the implementation of Six Sigma methodology'. *Journal of Manufacturing Technology Management*, Vol. 20, No. 7, pp. 957-974.

Nachmias, C. and Nachmias, D. (2000). *Research methods in the social sciences.* (6th ed.). New York: Worth Publishers.

Nash, M. A., Poling, S. R. and Ward, S. (2006). *Using lean for fast Six Sigma results: a synchronized approach.* New York: Productivity Press.

Naumann, E. and Hoisington, S. H. (2001). *Customer centred Six Sigma: integrating customers, process improvement, and financial results.* Milwaukee: ASQ Quality Press.

Nave D. (2002). 'How to compare Six Sigma, lean and the theory of constraints - A framework for choosing what's best for your organization', *Quality Progress*, Vol. 35, No. 3, pp. 73-78.

Neagu, R. and Hoerl, R. (2005). 'A Six Sigma approach to predicting corporate defaults'. *Quality and Reliability Engineering International*, Vol. 21, No. 3, pp. 293-309.

Neuman, W. L. (2003). *Social research methods: qualitative and quantitative approaches.* (5th ed.). Upper Saddle River: Pearson Education Inc.

Neuman, W. L. (2004). *Basics of social research: qualitative and quantitative approaches.* Boston; London: Pearson/Allyn and Bacon.

Neuscheler, F. D. and Norris, R. (2001). 'Capturing financial benefits from Six Sigma - five lessons learned will resonate with top management'. *Quality Progress*, Vol. 34, No. 5, pp. 39-44.

Niemes, J. (1999). 'Taking sales success to new heights with Six Sigma'. *National Productivity Review*, Vol. 18, No. 4, pp. 37-42.

Nilakantasrinivasan, N. and Nair, A. (2005). 'DMAIC failure modes'. *ASQ Six Sigma Forum Magazine*, Vol. 4, No. 3, pp. 30-34.

Niles, K. (2001a). 'Six Sigma via context'. *iSixSigma Insights Newsletter*, Vol. 2, No. 52.

Niles, K. (2001b). 'What makes Six Sigma work?'. *iSixSigma Insights Newsletter*, Vol. 2, No. 52.

Niles, K. (2002a). 'Maximize Six Sigma team performance'. *iSixSigma Insights Newsletter,* Vol. 3, No. 4.

Niles, K. (2002b). What are the benefits of Six Sigma over kaizen? *iSixSigma Insights Newsletter,* Vol. 3, No. 10.

Noble, T. (2001). 'Six Sigma boosts the bottom line'. *Chemical Engineering Progress,* Vol. 97, No. 4, pp. 9-11.

Nonthaleerak, P. and Hendry, L. (2005). *Six Sigma: Literature review and key future research areas.* Working paper series. Lancaster: Lancaster University Management School (LUMS), UK.

Nonthaleerak, P. and Hendry, L. (2008). Exploring the Six Sigma phenomenon using multiple case study evidence'. *International Journal of Operations and Production Management,* Vol. 28, No. 3, pp. 279-303.

Nunnally, J. C. and Bernstein, I. H. (1994). *Psychometric theory.* (3rd ed.). New York; London: McGraw-Hill.

Oakland, J. S. (1999). *Total organisational Excellence.* England: Butterworth-Heinemann.

Oakland, J. S. (2003). *Total quality management: text with cases.* Oxford: Elsevier.

Olexa, R. (2003). 'Driving quality with Six Sigma'. *Manufacturing Engineering,* Vol. 130, No. 2, p. 61.

Oppenheim, A. (1996). *Questionnaire design and attitude measurement.* London: Heinemann.

Pagell, M., Katz, J. P. and Sheu, C. (2005). 'The importance of national culture in operations management research'. *International Journal of Operations and Production Management,* Vol. 25, No. 4, pp. 371-394.

Pallant, J. F. (2001). *SPSS survival manual: a step by step guide to data analysis using SPSS for Windows (version 10).* Buckingham: Open University Press.

Pallant, J. F. (2007). *SPSS survival manual: a step-by-step guide to data analysis with SPSS.* (3rd ed.), Crows Nest, New South, Wales, Allen and Unwin.

Pande, P. S. (2007). *The Six Sigma leader.* New York: McGraw-Hill.

Pande, P. S. and Holpp, L. (2002a). Six Sigma overview.

Pande, P. S. and Holpp, L. (2002b). *What is Six Sigma?.* New York: McGraw-Hill.

Pande, P. S., Neuman, R. P. and Cavanagh, R. R. (2000). *The Six Sigma Way: How GE, Motorola, and other top companies are honing their performance.* New York: McGraw-Hill.

Pande, P. S., Neuman, R. P. and Cavanagh, R. R. (2002). *The Six Sigma way, team fieldbook: An implementation guide for process improvement teams.* New York: McGraw Hill.

Pande, P. S., Neuman, R. P. and Cavanagh, R. R. (2005). *What is design for Six Sigma?.* New York: McGraw-Hill.

Pandey, A. (2007). 'Strategically focused training in Six Sigma way: a case study'. *Journal of European Industrial Training,* Vol. 31, No. 2, pp. 145-162.

Park, S. H. (2003). *Six Sigma for quality and productivity promotion.* Tokyo: Asian Productivity Organisation.

Park, S. H., Lee, M. J. and Chung, M. Y. (1999). *Theory and practice of Six Sigma.* Seoul: Publishing Division, Korean Standards Association.

Park, S. H., Lee, M. J. and Lee, K. K. (2001). *DFSS: Design for Six Sigma.* Seoul: Publishing Division, Korean Standards Association.

Parody, R. J. and Voelkel, J. G. (2006). 'Six Sigma start-up at small companies'. *Quality Progress,* Vol. 39, No. 5, pp. 68-69.

Parr, W. C. (2006). 'Making Six Sigma last'. *ASQ Six Sigma Forum Magazine*, Vol. 5, No. 2, pp. 15-19.

Patterson, A., Bonissone, P. and Pavese, M. (2005). 'Six Sigma applied throughout the lifecycle of an automated decision system'. *Quality and Reliability Engineering International*, Vol. 21, No. 3, pp. 275-292.

Patton, F. (2005). 'Does Six Sigma work in service industries?'. *Quality Progress*, Vol. 38, No. 9, pp. 55-60.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Newbury Park: Sage.

Paul, L. (1999).'Practice makes perfect', *CIO Enterprise*, Vol. 12, No. 7, Section 2, January pp. 15.

Pearson, T. A. (2000). 'Six Sigma and the knowledge revolution'. *Annual Quality Congress Proceedings*, Milwaukee, pp. 723-727.

Pearson, T. A. (2001). 'Measurement for Six Sigma success'. *Quality Progress*, Vol. 34, No. 2, pp. 35-41.

Pepper, M. J. and Spedding T. A. (2010). 'The evolution of lean Six Sigma'. *International Journal of Quality and Reliability Management*, Vol. 27, No. 2, pp. 138-155.

Perez-Wilson, M. (1999). *Six Sigma: understanding the concept, implications and challenges*. Arizona: Advanced Systems Consultants.

Persse, J. R. (2006). *Process improvement essentials*. Sebastopol: O'Reilly.

Pestorius, M. (2006). *Applying the science of Six Sigma to the art of sales and marketing*. Milwaukee: ASQ Quality Press.

Pestorius, M. (2007). 'Apply Six Sigma to sales and marketing'. *Quality Progress*, Vol. 40, No. 1, pp. 19-24.

Peter, J. P. (1981). 'Construct validity: a review of basic issues and marketing practices'. *Journal of Marketing Research*, Vol. 18, No. 2, pp. 33-145.

Peters, T. and Waterman, R. (1982). *In Search of Excellence: Lessons from America's Best Run Companies*. New York: Harper and Row.

Pfeifer, T., Reissiger, W. and Canales, C. (2004). 'Integrating Six Sigma with quality management systems'. *The TQM Magazine*, Vol. 16, No. 4, pp. 241-249.

Phillips-Donaldson, D. (2003). 'Six Sigma: a false god?'. *Quality Progress*, Vol. 36, No. 1, p. 6.

Poole, A. (2000). 'Six Sigma: communication's perfect role'. *Strategic Communication Management*, Vol. 4, No. 2, pp. 34-38.

Povey, B. (1996). *Continuous business improvement: integrating the key improvement processes for your critical long-term success*. UK: McGraw-Hill.

Pries, K. H. (2006). *Six Sigma for the next millennium: a CSSBB guidebook*, Milwaukee: ASQ Quality Press.

Process Quality Associates (2004). What is Six Sigma? [online] Available: http://www.pga.net/sixsigma/w06002002.html [accessed 4/5/2005].

Przekop, P. (2006). *Six Sigma for business excellence: a manager's guide to supervising Six Sigma projects and teams*. New York: McGraw-Hill.

Punch, K. (2005). *Introduction to social research: quantitative and qualitative approaches*. London: Sage.

Pyzdek, T. (1999). *The complete guide to Six Sigma*. Tucson: Quality Publishing.

Pyzdek, T. (2000a). 'Six Sigma and lean production'. *Quality Digest*, Vol.14.

Pyzdek, T. (2000b). *The Six Sigma handbook: a complete guide for greenbelts, black belts and managers at all levels*. New York: McGraw-Hill.

Pyzdek, T. (2000c). 'What is a black belt?' *Quality Digest*, 22. [online] Available: http://www.qualitydigest.com [accessed 15/03/2007].

Pyzdek, T. (2001a). 'Six Sigma black belts: what do they need to know'. *Journal of Quality Technology*, Vol. 33, No. 4, pp. 418-420.

Pyzdek, T. (2001b). 'Why Six Sigma is not TQM'. *Quality Digest*, Vol. 21, No. 2, pp.26.

Pyzdek, T. (2003a). *DMAIC and DMADV*. [online] Available: http://www.pyzdek.com [accessed 17/7/2008].

Pyzdek, T. (2003b). *The Six Sigma handbook: a complete guide for green belts, black belts, and managers at all levels*. New York: McGraw-Hill.

Pyzdek, T. (2003c). *The Six Sigma project planner: a step-by-step guide to leading a Six Sigma project through DMAIC*. New York: McGraw-Hill.

Pyzdek, T. (2004). 'Strategy deployment using balanced scorecards'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 21-28.

Quinn, D. (2005). 'Six Sigma leaders'. *Quality*, Vol. 44, No. 3, p. 80.

Rahman, S. and Bullock, P. (2005). 'Soft TQM, hard TQM, and organizational performance relationships: an empirical investigation'. *Omega*, Vol. 33, No. 1, pp. 73-83.

Raisch, T., Anderson, J., Krogman, K. and Krueger, B. (2001). 'Six Sigma'. *Current Quality*, Vol. 28, pp. 81-87.

Raisinghani, M. S., Ette, H., and Pierce, R. (2005). 'Six Sigma: concepts, tools, and applications'. *Industrial Management and Data Systems*, Vol. 105, No. 4, pp. 491-505.

Rajagopalan, R., Francis, M. and Suarez, W. (2004). 'Developing novel catalysts with Six Sigma'. *Research Technology Management*, Vol. 47, No. 1, pp. 13-16.

Ramberg, J. S. (2000). 'Six Sigma: fad or fundamental?'. *Quality Digest*, May, pp. 28-32.

Rancour, T. and McCracken, M. (2000). 'Applying Six Sigma methods for breakthrough safety performance'. *Professional Safety*, Vol. 45, No. 10, pp. 29-33.

Rao, A. (1996). *Total quality management*. New York: John Wiley.

Rao, S., Subba, T., Ragu-Nathan, S. and Solis, L. E. (1997). 'Does ISO 9000 have an effect on quality management practices?- an international empirical study'. *Total Quality Management*, Vol. 8, pp. 335-346.

Rasis, D., Gitlow, H. S. and Popovich, E. (2003a). 'A fictitious Six Sigma Green Belt: case study, I'. *Quality Engineering*, Vol. 15, No. 1, pp.127-146.

Rasis, D., Gitlow, H. S. and Popovich, E. (2003b). 'A fictitious Six Sigma Green Belt: case study, II'. *Quality Engineering*, Vol. 15, No. 2, pp. 259-274.

Rath and Strong (2005). *Rath and Strong's workout for Six Sigma pocket guide: how to use GE's powerful tool to prepare for, reenergize, complement, or enhance a Six Sigma programme*. New York: McGraw-Hill.

Ravichandran, J. (2006). 'Six Sigma milestone: an overall sigma level of an organization'. *Total Quality Management*, Vol. 17, No. 8, pp. 973-980.

Reidenbach, R. E. and Goeke, R. W. (2006). *Strategic Six Sigma for champions: keys to sustainable competitive advantage*. Milwaukee: ASQ Quality Press.

Reidenbach, R. E. and Goeke, R. W. (2007). 'Six Sigma, value and competitive strategy'. *Quality Progress*, July.

Remenyi, D., Williams, B., Money, A. and Swartz, E. (2000). *Doing research in business and management: an introduction to process and method*. London: Sage.

Rencher, M. (2003). 'Six Sigma statistical methods strengthen designs'. *Electronic Engineering Times*, Vol. 15, pp. 57-61.

Revelle, J. B. (2004). 'Six Sigma: problem-solving techniques create safer, healthier worksites'. *Professional Safety*, Vol. 49, No. 10, p. 38.

Revere, L. and Black, K. (2003). 'Integrating Six Sigma with total quality management: a case example for measuring medication errors'. *Journal of Healthcare Management*, Vol. 48, No. 6, pp. 377-391.

Revere, L., Black, K. and Huq, A. (2004). 'Integrating Six Sigma and CQI for improving patient care'. *The TQM Magazine*, Vol. 16, No. 2, pp. 105-113.

Reynolds, P. (1979). *Ethical dilemmas and social science research*. San Francisco; London: Jossey-Bass.

Ritchie, J. and Lewis, J. (2003). *Qualitative research practice: a guide for social science students and researchers*. London: Sage.

Roberts, C. M. (2004). 'Six Sigma signals'. *Credit Union Magazine*, Vol. 70, No. 1, pp. 40-43.

Robson, C. (2002). *Real world research: a resource for social scientists and practitioner-researchers*. Oxford: Blackwell.

Rockart, J. (1979). 'Chief executives define their own data needs'. *Harvard Business Review*, Vol. 57, No .2, pp. 238-241.

Roscoe, A. M., Lang, D. and Sheth, J. N. (1975). 'Follow up methods, questionnaire length and market differences in mail surveys'. *Journal of Marketing*. Vol. 39, April, pp. 20-27.

Rosenberg, A. (2005). 'Six Sigma: the myth, the mystery, the magic'. *Call Centre Magazine*, Vol. 18, No. 2, p. 42.

Ross, J. E. (1993). *Total quality management: Text, cases, and readings*. Delray Beach: Lucie Press.

Rossman, G. B. and Rallis, S. F. (1998). *Learning in the field: an introduction to qualitative research*. London: Sage.

Rouda, R., Kusy, M. (1995). 'Development of Human Resources', Part 2. Technical Association of the Pulp and Paper Industry, Retrieved March 8, 2003 from the World Wide Web: http://alumni.caltech.edu/~rouda/T2_NA.html.

Rowlands, H. (2003). 'Six Sigma: a new philosophy or repackaging of old ideas?'. *Engineering Management*, Vol. 13, No. 2, pp. 18-21.

Rudisill, F. and Clary, D. (2004). 'The management accountant's role in Six Sigma'. *Strategic Finance*, Vol. 86, No. 5, pp. 34.

Rudisill, F. and Druley, S. (2004). 'Which Six Sigma metric should I use?'. *Quality Progress*, Vol. 37, No. 3, pp. 104-104.

Rungaswamy, S. and Antony, J. (2002). 'Critical success factors for SPC in UK SMEs: some key findings from a survey'. *The TQM Magazine*, Vol. 14, No. 4, pp. 217-224.

Ryan, B., Scapens, R. W. and Theobald, M. (2002). *Research method and methodology in finance and accounting*. London: Thomson.

Ryan, K. (2005). 'Mastering Six Sigma'. *American Gas*, Vol. 87, No. 7, pp.13-18.

Saffold, G.S. (1988). 'Cultural traits, strength, and organizational performance: Moving beyond strong culture'. *The Academy of Management Review*, Vol. 134, pp. 546-558.

Salzman, S., Rabeneck, L. T. and Rabeneck, S. K. (2002). *Comprehensive Six Sigma reference guide*. Kansas City, Missouri: Corporate Document Services.

Samuels, D. I. and Adomitis, F. L. (2003). 'Six Sigma can meet your revenue-cycle needs'. *Healthcare Financial Management*, Vol. 57, No. 11, pp. 70-76.

Sanders, D. and Hild, C. (2000a). 'A discussion of strategies for Six Sigma implementation'. *Quality Engineering*, Vol. 12, No. 3, pp. 303-309.

Sanders, D. and Hild, C. (2000b). 'Six Sigma on business processes: common organizational issues'. *Quality Engineering*, Vol. 12, No. 4, pp. 603-610.

Sanders, D. and Hild, C. (2000c). 'Common myths about Six Sigma'. *Quality Engineering*, Vol. 13, No. 2, pp. 269-276.

Sandholm, L. and Sorqvist, L. (2002). '12 requirements for Six Sigma success'. *ASQ Six Sigma Forum Magazine*, Vol. 2, No. 1, pp. 17-22.

Sarkar, D. (2004). *Lessons in Six Sigma: 72 must know truths for managers*. New Delhi; Thousand Oaks: Response Books.

Saunders, M., Lewis, P. and Thornhill, A. (2003). *Research methods for business students*. (3rd ed.). England: Prentice-Hall.

Savolainen, T. and Haikonen, A. (2007). 'Dynamics of organizational learning and continuous improvement in Six Sigma implementation'. *The TQM Magazine*, Vol. 19, No. 1, pp. 6-17.

Schein, E. H. (1985). *Organizational culture and leadership: a dynamic view*. San Francisco: Jossey-Bass Publishers.

Schmitt, B. (2000). 'Moving ahead with Six Sigma'. *Chemical Week*, Vol. 162, No. 17, pp. 64-68.

Schmitt, B. (2001). 'Expanding Six Sigma'. *Chemical Week*, Vol. 163, No. 8, pp. 21-23.

Schmitt, B. (2002). 'A slow spread for Six Sigma'. *Chemical Week*, Vol. 164, No. 6, pp. 34-36.

Schön, K., Bergquist, B. and Klefsjö, B. (2010). 'The consequences of Six Sigma on job satisfaction: a study at three companies in Sweden'. *International Journal of Lean Six Sigma,* Vol. 1, No. 2, pp. 99-118.

Schroeder, R. G. (2000). 'Six Sigma quality improvement: what is Six Sigma and what are the important implications?' *Proceedings of the Fourth Annual International POMS Conference,* Seville, Spain, Aug. 27-Sep.

Schutta, J. T. (2006). *Business performance through lean Six Sigma: integrating the knowledge worker, the twelve pillars, and Baldridge.* Milwaukee: ASQ Quality Press.

Sciarelli, S. (2002). 'Business quality and business ethics'. *Total Quality Management,* Vol. 13, No. 8, pp. 1141-1149.

Sehwail, I. and Deyong, C. (2003). 'Six Sigma in health care'. *International Journal of Health Care Quality Assurance,* Vol. 16, No. 6, pp. 1-5.

Sekaran, U. (2003). *Research methods for business: a skill-building approach.* New York: John Wiley.

Senapati, N. R. (2004). 'Six Sigma: myths and realities'. *The International Journal of Quality and Reliability Management,* Vol. 21, No. 6, pp. 683-698.

Sha'ri, M. and Aspinwall, E. (2000). 'TQM implementation issues: review and case study'. *International Journal of Operations and Production Management,* Vol. 20, No. 6, pp. 634-655.

Shahin, A. (2006). 'Critical success factors: a comprehensive review'. *International conference on problem solving strategies and techniques,* Tehran, 26-27 November.

Shahin, A. (2007). 'Analysis of Six Sigma Critical Success Factors in Iranian Car Making Companies'. *Proceedings of Middle East Quality Association (MEQA) 1st International Annual Congress* (March 25 -27, 2007) Dubai.

Shanmugam, V. (2007). 'Six Sigma cup: establishing ground rules for successful Six Sigma deployment'. *Total Quality Management,* Vol. 18, No. 1-2, pp. 77-82.

Shapiro, M. and Weeks, A. (2005). *The pocket idiot's guide to Six Sigma.* Indianapolis: Alpha.

Shina, S. G. (2002). *Six Sigma for electronics design and manufacturing.* New York: McGraw-Hill.

Silverman, D. (2000). *Doing qualitative research- a practical handbook.* Thousand Oaks; London: Sage.

Sleeper, A. D. (2006a). *Design for Six Sigma statistics: 59 tools for diagnosing and solving problems in DFSS initiatives.* New York: McGraw-Hill.

Sleeper, A. D. (2006b). *Six Sigma: distribution modelling.* New York: McGraw-Hill.

Smith, D., Blakeslee, J. and Koonce, R. (2003). *Strategic Six Sigma: best practices from the executive suite.* Hoboken: John Wiley.

Smith, H. W. (1981). *Strategies of social research - the methodological imagination.* Englewood Cliffs, N.J.: Prentice Hall.

Smith, K. (2003). 'Six Sigma for the service sector'. *Quality Digest.* [online] Available: http://www.qualitydigest.com [accessed 15/03/2008].

Smith, L. R. (2001). 'Six Sigma and the evolution of quality in product development'. *ASQ Six Sigma Forum Magazine,* November, pp. 28-35.

Snee, R. D. (1990). 'Statistical thinking and its contribution to total quality'. *The American Statistician,* Vol. 44, No. 2, pp. 116-121.

Snee, R. D. (1999). Why should statisticians pay attention to Six Sigma? An examination for their role in the Six Sigma methodology. *Quality Progress,* Vol. 32, No. 9, pp.100-103.

Snee, R. D. (2000). 'Impact of Six Sigma on quality engineering'. *Quality Engineering,* Vol. 12, No. 3, pp. 9-14.

Snee, R. D. (2000a). 'Six Sigma improves both statistical training and processes'. *Quality Progress,* Vol. 33, No. 10, pp. 68-73.

Snee, R. D. (2000b). 'Using Six Sigma in improving health care systems'. *Annual Quality Congress Proceedings.* Milwaukee, pp. 571-572.

Snee, R. D. (2001a). 'Dealing with the Achilles heel of Six Sigma initiatives'. *Quality Progress*, Vol. 34, No. 3, pp. 66-70.

Snee, R. D. (2001b). 'Six Sigma black belts: what do they need to know?'. *Journal of Quality Technology*, Vol. 3, No. 4, pp. 414-417.

Snee, R. D. (2004). 'Six Sigma: the evolution of 100 years of business improvement methodology'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 4-20.

Snee, R. D. (2005). 'When worlds collide: Lean and Six Sigma'. *Quality Progress*, Vol. 38, No. 9, pp. 63-65.

Snee, R. D. (2006). 'What can improve Six Sigma's effectiveness?'. *ASQ Six Sigma Forum Magazine*, Vol. 5, No. 2, pp. 12-13.

Snee, R. D. and Hoerl R. W. (2003). *Leading Six Sigma: A step-by-step guide based on experience with GE and other Six Sigma companies.* Upper Saddle River, NJ: Financial Times, Prentice Hall.

Snee, R. D. and Hoerl, R. W. (2005). *Six Sigma beyond the factory floor: deployment strategies for financial services, health care, and the rest of the real economy.* Upper Saddle River: Pearson Prentice Hall.

Snee, R. D. and Rodenbaugh, W. F. (2002). 'The project selection processes'. *Quality Progress*, Vol. 35, No. 9, pp. 78-80.

Sproull, N. (1988). *Handbook of research methods: a guide for practitioner and student in the social sciences.* USA: Scarecrow Press.

Staggs, P. (1999). 'Strategic planning as a total quality management critical success factor'. *Journal of Organizational Leadership*, Vol. 1, No. 1, pp. 5-176.

Stagliano, A. A. (2004). *Rath and Strong's Six Sigma advanced tools pocket guide.* New York: McGraw-Hill.

Stamatis, D. H. (2000). 'Who needs Six Sigma, anyway?'. *Quality Digest,* retrieve from www.qualitydigest.com.

Stamatis, D. H. (2002). *Six Sigma and beyond: foundations of excellent performance.* New York: Lucie Press.

Stamatis, D. H. (2003). *Six Sigma for financial professionals.* Hoboken: John Wiley.

Stamatis, D. H. (2004). *Six Sigma fundamentals: a complete guide to the system, methods and tools.* New York: Productivity Press.

Stanley, A. and Marash, P. E. (2000). 'Six Sigma business results through innovation', *ASQ 54th Annual Quality Congress Proceedings, ASQ,* Milwaukee, Wisconsin,.

Starbid, D. (2002). Business Excellence: Six Sigma as a Management System. *ASQ's 56th Annual Quality Congress Proceedings,* 47-55.

Stator, R. (2001). *The GE Way Field book..* New York: McGraw-Hill.

Stephens, K. S. (2003). *Six Sigma and related studies in the quality disciplines.* Milwaukee: ASQ Quality Press.

Stewart, R. A. and Spencer, C. A. (2006). 'Six Sigma as a strategy for process improvement on construction projects: a case study'. *Construction Management and Economics,* Vol. 24, pp. 339-348.

Strauss, A. and Corbin, J. (1990). *Basics of qualitative research: grounded theory procedures and techniques.* London: Sage.

Studt, T. (2002). 'Implementing Six Sigma in R and D'. *R and D Magazine*, Vol. 44, No. 8, pp. 21-23.

Summers, D. S. (2007). *Six Sigma: basic tools and techniques.* Upper Saddle River: Pearson/Prentice Hall.

Sutton, C. (2006). 'Get the most out of Six Sigma'. *Quality*, Vol. 45, No. 3, pp. 46-48.

Swinney, Z. (2001). 1.5 Sigma Process Shift Explanation. [online] Available: http://www.isixsigma. [accessed 4/7/2009]

Szeto, A. Y. T. and Tsang, A. H. C. (2005). 'Antecedents to successful implementation of Six Sigma'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 3, pp. 307-322.

Tadikamalla, P. R. (2005). 'The confusion over Six Sigma quality'. *Quality Progress*, Vol. 27, No. 11, pp. 83-85.

Taghizadegan, S. (2006). *Essentials of lean Six Sigma*. Amsterdam; Boston: Elsevier.

Tahmooresi S. F., Noorossana, R. and Kiani, H. (2006). *Determination of critical success factors in Six Sigma projects implementation in car making companies*, M.S. Thesis, Department of Industrial Engineering, Faculty of Postgraduate Studies, Islamic Azad University, Najafabad Branch, Iran.

Tan, P. and Liang, K. (1997). 'An evaluation of TQM and the techniques for successful implementation'. *Training for Quality*, Vol. 5, No. 4, pp. 150-159.

Taner, M. T. Sezen, B. and Antony, J. (2007). 'An overview of Six Sigma applications in healthcare industry'. *International Journal of Health Care Quality Assurance*, Vol. 20, No. 4, pp. 329-340.

Tang, L. C. (2006). *Six Sigma: advanced tools for black belts and master black belts.* Hoboken: Wiley.

Tang, L. C., Goh, T. N., Lam, S. W. and Zhang, C. W. (2007). 'Fortification of Six Sigma: expanding the DMAIC toolset'. *Quality and Reliability Engineering International*, Vol. 23, pp. 3-18.

Tannock, J. T., Balogun, O. and Hawisa, H. (2007). 'A variation management system supporting Six Sigma'. *Journal of Manufacturing Technology Management*, Vol. 18, No. 5, pp. 561-575.

Tashakkori, A. and Teddlie, C. (1998). *Mixed methodology: combining qualitative and quantitative approaches.* Thousand Oaks; London: Sage.

Tennant, G. (2001). *Six Sigma: SPC and TQM in manufacturing and services.* Aldershot: Gower.

Tennant, G. (2002). *Design for Six Sigma: launching new products and services without failure*. Aldershot: Gower.

Tennant, G. (2003). *Pocket TRIZ for Six Sigma: systematic innovation and problem solving.* Bristol: Mulbury Consulting.

Thawani, S. (2004). 'Six Sigma - strategy for organizational excellence'. *Total Quality Management*, Vol. 15, No. 5, pp. 655-664.

Thevnin, C. (2004). 'Effective management commitment enhances Six Sigma success'. *Handbook of Business Strategy*, pp.195-200.

Thiagaran T. and Zairi M. (1997). 'A review of total quality management in practice: understanding the fundamentals through examples of best practice applications Part 1'. *The TQM Magazine*, Vol. 9, No. 4, pp. 270-286.

Thomas, A. and Barton, R. (2006). 'Developing an SME based Six Sigma strategy'. *Journal of Manufacturing Technology Management*, Vol. 17, No. 4, pp. 417-434.

Thompson, K. R. (1998). 'Confronting the paradoxes in a total quality environment', *Organizational Dynamics*, Vol. 26, No. 3, pp. 62-74.

Thomsett, M. C. (2005). *Getting started in Six Sigma*. Hoboken: Wiley.

Todd, D. J. (1979). 'Mixing qualitative and quantitative methods: triangulation in action'. *Administrative Science Quarterly*, Vol. 24, pp. 602-611.

Tom, Q. (2003). 'DMAIC'. [online] Available: http://www.isixsigma.com/sixsigma. [accessed 13/7/2008].

Treichler, D. H. and Carmichael, R. D. (2004). *The Six Sigma path to leadership: observations from the trenches*. Milwaukee: ASQ Quality Press.

Treichler, D., Carmichael, R., Kusmanoff, A., Lewis, J. and Berthiez, G. (2002). 'Design for Six Sigma: 15 lessons learned'. *Quality Progress*, Vol. 35, No. 1, pp. 33-42.

Trivedi, B. (2002). 'Applying Six Sigma'. *Chemical Engineering Progress*, Vol. 98, No. 7, pp. 76-81.

Trochim, W. M. (2001). *Research methods knowledge base.* (2nd ed.). Cincinnati: Atomic Dog Publishing.

Truscott, W. G. (2003). *Six Sigma: continual improvement for business: a practical guide.* Amsterdam; Boston: Butterworth-Heinemann.

Trusko, B. E. (2007). *Improving healthcare quality and cost with Six Sigma*. Indianapolis: Financial Times, Prentice Hall.

Tylutki, D. P. and Fox, D. G. (2002). 'Mooooving toward Six Sigma'. *Quality Progress*, Vol. 35, No. 2, pp. 34-42.

Van Der, W. A., Williams, A. R. and Dale, B. G. (2000). 'ISO 9000 series registration to business excellence: the migratory path'. *Business Process Management Journal*, Vol. 6, No. 5, pp. 417.

Vaugham, T. S. (1998). 'Defect rate estimation for Six Sigma processes'. *Production and Inventory Management Journal*, Vol. 39, No. 4, pp. 5-10.

Velocci, A. (1998a). 'Pursuit of Six Sigma emerges as industry trend'. *Aviation Week and Space Technology*, Vol. 149, No. 20, pp. 52-53.

Velocci, A. (1998b). 'High hopes riding on Six Sigma at Raytheon'. *Aviation Week and Space Technology*, Vol. 149, No. 20, pp. 59-60.

Velocci, A. (1998c). 'Six Sigma takes a back seat to Lean electronics at Rockwell'. *Aviation Week and Space Technology*, Vol. 149, No. 20, pp. 60-62.

Velocci, A. (2000). 'Raytheon Six Sigma meets initial target'. *Aviation Week and Space Technology*, Vol. 152, No. 13, pp. 59.

Velocci, A. (2002). 'Full potential of Six Sigma eludes most companies'. *Aviation Week and Space Technology*, Vol. 157, No. 14, pp. 56-60.

Vinzant, J. C. and Vinzant, D. H. (1996). 'Strategic management and total quality management: challenges and choices'. *Public Administrative Quarterly*, Vol. 20, No. 2, pp. 201-217.

Voelkel, J. G. (2004). 'What is 3.4 per million?'. *Quality Progress*, Vol. 37, No. 5, pp. 63-65.

Voelkel, J. G. (2005). 'What makes a Six Sigma project successful?'. *Quality Progress*, Vol. 38, No. 5, pp. 66-68.

Vonderheide, D. and Pate, B. (2004). *Applying quality methodologies to improve healthcare: Six Sigma, lean thinking, balanced scorecard, and more*. Marblehead: HC Pro.

Walsh, K., Fuller, J., Wood, A., Moore, S., Seewald, N. and Schmitt, B. (2000). 'Six Sigma - Marshaling an attack on costs'. *Chemical Week*, Vol. 162, No. 9, pp. 25-27.

Walters, L. (2005). 'Six Sigma: is it really different?'. *Quality and Reliability Engineering International*, Vol. 21, No. 3, pp. 221-224.

Wang, F. K., Du, T. C. and Li, E. Y. (2004). 'Applying Six Sigma to supplier development'. *Total Quality Management and Business Excellence*, Vol. 15, No. 9, pp. 1217-1229.

Wang, J. X. (2005). *Engineering robust designs with Six Sigma*. Upper Saddle River: Prentice Hall.

Warnecke, H. J. and Huser, M. (1995). 'Lean Production'. *International Journal of Production Economics*, Vol. 47, pp. 37-43.

Warwick, D. P. and Lininger, C. A. (1975). *The sample survey: theory and practice*. New York; London: McGraw-Hill.

Waterman, B. (1996). 'Does total quality apply to knowledge work? Absolutely!'. *Journal of Quality and Participation*, Vol. 19, No. 6, pp. 6-12.

Watson, G. H. (2001). 'Toward a central tendency on Six Sigma: a reasonable middle ground is starting to emerge'. *Quality Progress*, Vol. 33, No. 7, pp. 16-17.

Watson, G. H. (2002b). 'Selling Six Sigma to upper management'. *ASQ Six Sigma Forum Magazine*, Vol. 1, No. 4, pp. 26-37.

Watson, G. H. (2003). 'Six Sigma: fantasy, fad or fact?'. *25th* Annual John Loxham Lecture, Glasgow, Scotland, 13 November, pp. 1-8.

Watson, G. H. (2007). 'Change management: how important is it for Six Sigma?'. *ASQ Six Sigma Forum Magazine*, Vol. 6, No. 4, pp. 30-39.

Waxer, C. (2002). 'Six Sigma: cost and savings'. [online] Available: http://www.isixsigma.com/library/content/. [accessed 17/7/2008].

Waxer, C. (2005). 'Top ten Six Sigma black belt candidate qualities'. [online] Available: http://www.isixsigma.com/library/content/. [accessed 17/7/2008].

Weber, A. (2004). 'Caterpillar on track for big growth'. *Assembly*, Vol. 47, No. 1, pp. 90-93.

Wedgwood, I. (2007). *Lean Sigma: a practitioner's guide*. Upper Saddle River: Prentice Hall.

Weiner, M. (2004). 'Six Sigma: Applied research for improved public relations'. *Communication World*, Vol. 21, No. 1, pp. 26-29.

Welch, J. (1996). 'GE quality 2000'. *Executive Speeches*, August/September.

Welch, J. and Byrne, J. (2002). *Jack: Straight from the Gut*. New York, NY: Warner Books.

Wessel, G. and Burcher, P. (2004). 'Six Sigma for small and medium-sized enterprises'. *The TQM Magazine*, Vol. 16, No. 4, pp. 264-272.

Westgard, J. O. (2006). *Six Sigma quality design and control: desirable precision and requisite QC for laboratory measurement processes*. Madison: Westgard QC.

Wheeler, D. J. (2005). *The Six Sigma practitioner's guide to data analysis*. Knoxville: SPC Press.

Wheeler, J. (2002). 'Getting started with Six Sigma'. *Chemical Engineering Progress*, Vol. 98, No. 9, pp. 8.

Whitacre, T. (2006). 'Use DMAIC to enhance your career'. *Quality Progress*, Vol. 39, No. 6, pp. 70.

White, G. T. and Samson, P., Rowland-Jones, R. and Thomas, A. J. (2009). 'The implementation of a quality management system in the not-for-profit sector'. *The TQM Magazine*, Vol. 21, No. 3, pp. 273-283.

Wiklund, P. S. (2002). 'Widening the Six Sigma concept: an approach to improve organizational learning'. *Total Quality Management*, Vol. 13, No. 2, pp. 233-240.

Williams, T. A. (2003). 'Six Sigma is legit'. *Quality*, Vol. 42, No. 3, pp. 6.

Wilson, G. (1994). *On route to perfection: a guide to achieving Six Sigma*. Kempston: IFS International.

Windsor, S. E. (2006). *Transactional Six Sigma for green belts: maximizing service and manufacturing processes*. Milwaukee: ASQ Quality Press.

Wood, A. (2001). 'Making Six Sigma benefits stick'. *Chemical Week*, Vol. 163, No. 19, pp. 40.

Woodall, T. (2001). 'Six Sigma and service quality'. *Journal of Marketing Management*, Vol. 17, No. 5, pp. 595-608.

Wyper, B. and Harrison, A. (2000). 'Deployment of Six Sigma methodology in human resource function: a case study'. *Total Quality Management*, Vol. 11, No. 4, pp. S720-S728.

Yang, C. (2004). 'An integrated model of TQM and GE Six Sigma'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 97-111.

Yang, K. (2004). 'Multivariate statistical methods and Six Sigma'. *International Journal of Six Sigma and Competitive Advantage*, Vol. 1, No. 1, pp. 76-96.

Yang, K. and El-Haik, B. (2003). *Design for Six Sigma: a roadmap for product development*. New York: McGraw-Hill.

Yates, J. S. (2004). *Doing social science research*. London, Sage Publications in association with the Open University Press.

Yin, R. K. (2003). *Case study research, design and methods*. (3rd ed.). Newbury Park: Sage Publications

Young, A. (2001). 'Six Sigma: creating a competitive advantage'. *Journal of Strategy and Business Transformation*, Vol. 1, pp. 1-4.

Young, T. M. and Guess, F. M. (1994). 'Reliability processes and corporate structures'. *Microelectronics and Reliability*, Vol. 34, No. 6, pp. 1107-1119.

Zavacki, J. (2001). 'Customer centred Six Sigma: integrating customers, process improvement and financial'. *Quality Progress*, Vol. 34, No. 8, p. 110.

Zikmund, W. G. (2003). *Business research methods*. (7th ed.). Fort Worth: Mason Dryden Press.

Zimmerman, J. P. and Weiss, J. (2005). 'Six Sigma's seven deadly sins'. *Quality*, Vol. 44, No. 1, pp. 62-67.

Zinkgraf, S. A. (2006). *Six Sigma: the first 90 days*. Upper Saddle River: Prentice Hall.

APPENDICES

APPENDICES

Appendix A: Research Questionnaire

BRADFORD
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School of Management

Questionnaire on Six Sigma Implementation in Middle East Organisations

Dear Six Sigma Professional,

We are a team of researchers at the University of Bradford, UK, conducting research on the implementation of the Six Sigma quality system in Middle East organisations. For this purpose, we are approaching a number of organisations to take part in a survey relating to their experiences in implementing the Six Sigma project. So we would be most grateful if you could spare some time to complete the enclosed questionnaire relating to your opinion and the experience of your organisation. This will be extremely valuable to our research. You can withhold your name and address and other confidential information if you wish.

We would very much appreciate your participation since the success of the research is dependent on receiving the maximum number of responses from participants with your valuable experience. The questionnaire has been designed to make completion simple, easy and speedy. We appreciate that the questionnaire (9 sections, 25 questions) (5 pages) may take some of your valuable time; however, we have ensured that this will take not more than 20 minutes to complete.

We guarantee that all responses and information collected will be treated in the strictest confidence and will be used only for the purpose of the study. No organisation or individual will be named in any ensuing publication. According to University policy, all collected data will be destroyed after analysis. Please do not hesitate to contact us if you have any questions on this matter or if you require further information or clarification. We look forward to receiving your completed questionnaire in the near future. If you would like to see the overall results of this study, please provide contact information in the space at the end of the questionnaire.

To increase the accuracy of the results, we need more organisations and people to participate in this survey. If you know any other Six Sigma organisations or professionals, please forward the original questionnaire file to them.

Thank you very much; we appreciate your kind co-operation in working with us.

Yours sincerely,

Research team

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Questionnaire onSix Sigma Implementation in Middle East Organisations

Questionnaire no.: (......)

SECTION 1: ORGANISATION

1. Name of organisation (Optional): -------------------------

- *Please tick in the appropriate box - only one box:*

2. Location of organisation:

☐ Saudi Arabia	☐ Egypt	☐ United Arab Emirates (UAE)

3. Organisation sector:

☐ Manufacturing Sector, please specify:
☐ Services Sector, please specify:
☐ Any other, please specify:

4. Organisation size (according to number of employees):

Small-Medium Enterprise (SME) (≤ 250)	☐ 1 - 25	☐ 26 - 50
	☐ 51 - 150	☐ 151 - 250
Large Organisation (> 250)	☐ 251 - 500	☐ 501 - 1000
	☐ 1001 - 2500	☐ 2501 - 5000
	☐ 5001 - 10000	☐ More than 10000

****

SECTION 2: RESPONDENT

1. Your name (Optional): ------------------

2. Your nationality: -----------------------

- *Please tick in the appropriate box - only one box:*

3. Your organisational position in the organisation:

☐ Managerial	☐ Operational

4. Your Six Sigma certification:

☐ Champion	☐ Master Black Belt	☐ Black Belt	☐ Green Belt

5. How long have you been working in the organisation?

☐ Less than 2 years	☐ Less than 4 years	☐ Less than 6 years
☐ Less than 8 years	☐ Less than 10 years	☐ More than 10 years

6. How long have you been Six Sigma certified/qualified?

☐ Less than 2 years	☐ Less than 4 years	☐ Less than 6 years
☐ Less than 8 years	☐ Less than 10 years	☐ More than 10 years

7. How many Six Sigma projects have you been involved with in the past?

☐ 1 - 10	☐ 11 - 20	☐ 21 - 30
☐ 31 - 40	☐ 41 - 50	☐ More than 50

****

SECTION 3: SIX SIGMA PROGRAMME

- *Please tick in the appropriate box - only one box:*

1. When was the Six Sigma programme started in the organisation?

☐ Less than 10 years	☐ Less than 7 years	☐ Less than 5 years
☐ Less than 3 years	☐ Less than 1 year	

2. Who are the primary responsible of the Six Sigma programme in the organisation?

☐ CEO	☐ Director	☐ Division General Manager
☐ Functional Manager	☐ External (Consultant)	☐ Any other, please specify

3. What other quality improvement programmes were already implemented when the Six Sigma programme started? *Please tick in the appropriate boxes:*

☐ Total Quality Management (TQM)	☐ Benchmarking	☐ ISO-9001
☐ Business Process Re-engineering (BPR)	☐ Any other, please specify	

****

SECTION 4: SIX SIGMA IMPLEMENTATION

- *Please tick in the appropriate box - only one box:*

1. What is the present status of the Six Sigma implementation?

☐ Full	☐ Partial	☐ Start	☐ Any other, please specify:

2. If not fully implemented, in which stage of Six Sigma is your organisation?

☐ Planning	☐ Training	☐ Start-up
☐ Define	☐ Measure	☐ Analyse
☐ Improve	☐ Control	☐ Review
☐ Any other, please specify:		

3. How many Six Sigma projects have been implemented so far in your organisation?

☐ 1 - 5	☐ 6 - 10	☐ 11 - 15
☐ 16 - 25	☐ 26 - 40	☐ More than 40

4. What was the average project time for the implementation of the Six Sigma project?

☐ 1 - 4 months	☐ 5 - 8 months	☐ 9 - 12 months
☐ 13 -15 months	☐ 15 + months	

5. What percentage of total employees are involved in Six Sigma programmes?

☐ 1 - 20%	☐ 21 - 30%	☐ 31 - 40%
☐ 41 - 50%	☐ More than 50%	

6. What was the level of organisational resistance to Six Sigma programme?

☐ No resistance	☐ Minor resistance	☐ Moderate resistance
☐ Major resistance	☐ Great resistance	☐ Very great resistance

7. To what extent is use of external consultants important in planning and implementation of the Six Sigma programme?

☐ Very important	☐ Neutral	☐ Not at all
☐ Important	☐ Not important	

****

SECTION 5: REASONS FOR/ BENEFITS OF SIX SIGMA IMPLEMENTATION

- In your opinion, what was the significance of the following reasons/benefits in driving your organisation to implement Six Sigma projects? (Please tick only one box).

No.	Reasons for/ benefits of Six Sigma implementation	Rating: Not at all 1	2	3	4	Highly Significant 5
1	Improving customer satisfaction (understanding customer needs and expectations)	☐	☐	☐	☐	☐
2	Improving business, financial performance and organisation efficiency	☐	☐	☐	☐	☐
3	Reducing defect /error rate, waste chain reduction and process cycle times	☐	☐	☐	☐	☐
4	Planning strategically and positively (measuring pre-defined goals and defining full layout of processes)	☐	☐	☐	☐	☐
5	Gaining competitive advantage	☐	☐	☐	☐	☐
6	Empowering, encouraging and improving decision making role (improved communications, education, knowledge, creativeness and cross-functional teamwork)	☐	☐	☐	☐	☐
7	Changing and improving organisation culture	☐	☐	☐	☐	☐
8	Achieving faster and on-time delivery	☐	☐	☐	☐	☐
9	Decreasing employee work loads for undesirable work	☐	☐	☐	☐	☐
10	Improving employees effectiveness, efficiencies and satisfaction in their performance	☐	☐	☐	☐	☐
11	Reducing capital spending (operational costs, overhead production costs)	☐	☐	☐	☐	☐
12	Using resources effectively	☐	☐	☐	☐	☐
13	Building organisation reputation and creating new customer opportunities	☐	☐	☐	☐	☐
14	Improving process performance continuously from reactive to proactive	☐	☐	☐	☐	☐
15	Improving and increasing earnings, profitability and market share	☐	☐	☐	☐	☐
	Any others, please specify					
--		☐	☐	☐	☐	☐
--		☐	☐	☐	☐	☐
--		☐	☐	☐	☐	☐

****

SECTION 6: CHALLENGES OF SIX SIGMA IMPLEMENTATION

- Please rate the significance of challenges experienced in Six Sigma programme implementation (Please tick only one box).

No.	Challenges of Six Sigma implementation	Rating: Not at all 1	2	3	4	Highly Significant 5
1	Lack of top management commitment and support	☐	☐	☐	☐	☐
2	Lack of communication	☐	☐	☐	☐	☐
3	Organisational resistance (fear of change)	☐	☐	☐	☐	☐
4	Lack of teamworking	☐	☐	☐	☐	☐
5	Lack of resources	☐	☐	☐	☐	☐
6	Cost of training and consulting and long time needed for training	☐	☐	☐	☐	☐
7	Selecting suitable projects	☐	☐	☐	☐	☐
8	Lack of measurement of customer satisfaction	☐	☐	☐	☐	☐
9	Lack of rewarding system	☐	☐	☐	☐	☐
10	Lack of data availability, collection and analysis	☐	☐	☐	☐	☐
11	Insufficient training	☐	☐	☐	☐	☐
12	Poor project management	☐	☐	☐	☐	☐
13	Lack of implementing statistical tools and techniques	☐	☐	☐	☐	☐
	Any others, please specify					
--		☐	☐	☐	☐	☐
--		☐	☐	☐	☐	☐

****

SECTION 7: CRITICAL SUCCESS FACTORS OF SIX SIGMA IMPLEMENTATION

- Based on your Six Sigma implementation experience, please rate the significance of critical factors for successful implementation of the Six Sigma programme (Please tick only one box).

No.	Critical Success Factors of Six Sigma implementation	Rating: Not at all 1	2	3	4	Highly Significant 5
1	Top management commitment and support	☐	☐	☐	☐	☐
2	Readiness for cultural change	☐	☐	☐	☐	☐
3	Continuous training and education	☐	☐	☐	☐	☐
4	Teamwork	☐	☐	☐	☐	☐
5	Effective communication	☐	☐	☐	☐	☐
6	Formation of Six Sigma organisational structure	☐	☐	☐	☐	☐
7	Integrating Six Sigma with customer satisfaction	☐	☐	☐	☐	☐
8	Integrating Six Sigma with corporate business strategy	☐	☐	☐	☐	☐
9	Integrating Six Sigma with employees	☐	☐	☐	☐	☐
10	Integrating Six Sigma with suppliers	☐	☐	☐	☐	☐
11	Integrating Six Sigma with financial goals	☐	☐	☐	☐	☐
12	Integrating Six Sigma with existing initiatives	☐	☐	☐	☐	☐
13	Integrating Six Sigma with rewards and recognition system	☐	☐	☐	☐	☐
14	Use of Six Sigma methodologies and tools	☐	☐	☐	☐	☐
15	Project management skills	☐	☐	☐	☐	☐
16	Project prioritisation, selection, evaluation, tracking and reviews	☐	☐	☐	☐	☐
17	Integrating Six Sigma with information technology (IT) infrastructure	☐	☐	☐	☐	☐
18	Competitive benchmarking for Six Sigma	☐	☐	☐	☐	☐
19	Use of external consultants	☐	☐	☐	☐	☐
	Any others, please specify					
--		☐	☐	☐	☐	☐
--		☐	☐	☐	☐	☐

SECTION 8: ORGANISATION SATISFACTION WITH RESULTS ACHIEVED THROUGH SIX SIGMA IMPLEMENTATION

- Based on your Six Sigma implementation experience, please judge your organisation's satisfaction with the results achieved through Six Sigma implementation (Please tick only one box)

Organisation satisfaction with Six Sigma implementation	Rating				
	H. dissatisfied				H. satisfied
	1	2	3	4	5
Organisation satisfaction with results achieved through Six Sigma implementation	☐	☐	☐	☐	☐

****

SECTION 9: COMMENTS

- Any other comments/information you would like to share regarding the Six Sigma implementation:

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THANK YOU FOR YOUR TIME, VALUABLE INPUT AND KIND COOPERATION

If you would like a copy of the study results report, please complete the following details:

Name: ....
Organisation: ....
Address: ....
Contacts: Tel. No.: ....
Mobile No.: ....
E-mail: ....

Would you like to get involved in the second stage of this research (personal interview)?

☐ Yes ☐ No

****

Appendix B: Research Interview Questions

BRADFORD
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School of Management

Six Sigma Implementation in Middle East Organisations

INTERVIEW QUESTIONS

Interview Guide
This guide lists a pre-determined set of questions that are to be explored during an interview. This guide serves as a road map and checklist during the interview and ensures that basically the same information is obtained from all the interviewees.

Semi-structured interview questions with Six Sigma organisations' senior top management, quality managers, Six Sigma persons who are qualified/certified, Champions, Master Black Belts (MBBs), Black Belts (BBs) and Green Belts (GBs) about the Six Sigma implementation in Saudi, Egyptian and Emirates' organisations.

Interview no.: (.......)
Interview date: (..............)

****

SECTION 1: PROFILE OF RESPONDING ORGANISATION

Purpose: To obtain some information about the organisation

1. Name of organisation (optional): ....
2. Location of organisation: ....
3. Nature (sector) of organisation: ....
4. Size of organisation (Number of employees): ....

****

SECTION 2: PERSONAL (RESPONDENT) PROFILE

Purpose: To obtain the personal (respondent) profile

1. What is your name (optional)? ....
2. What is your nationality? ....
3. What is your organisational position in your organisation? ....
4. What is your Six Sigma role? ....
5. How long have you been working in the organisation? ....
6. How long have you been Six Sigma certified/qualified? ....
7. How many Six Sigma projects have you been involved with in the past? ....

****

SECTION 3: ABOUT SIX SIGMA PROGRAMME

Purpose: To obtain information about Six Sigma implementation programme in the organisation.

1. When was the Six Sigma programme started in your organisation? ....
2. Who are the primary responsible of Six Sigma programme in your organisation? ....
3. What other quality improvement programmes were already implemented when Six Sigma programme started? ....

****

SECTION 4: SIX SIGMA IMPLEMENTATION

Purpose: To determine how Six Sigma programme was implemented in the organisation.

1. What is the present status of the Six Sigma implementation? ....
2. If not fully implemented, which stage of Six Sigma is your organisation in? ....
3. How many Six Sigma projects have been implemented so far in your organisation? ....
4. What was the average project time for implementation of Six Sigma project? ....
5. What percentage of the total employees are involved in Six Sigma programmes? ....
6. What was the level of organisational resistance to Six Sigma programme? ....
7. What was the importance of external consultants involved in planning and implementation of Six Sigma programme? ....

****

SECTION 5: REASONS FOR/ BENEFITS OF SIX SIGMA IMPLEMENTATION

Purpose: To determine the main reasons for/ benefits of Six Sigma implementation in the organisation.

- Based on your experience of Six Sigma implementation, could you please indicate *what were the main reasons/benefits that drove your organisation to implement Six Sigma projects? Or what are the main organisational benefits, potential and actual, achieved through implementing Six Sigma in your organisation?*

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SECTION 6: CHALLENGES FACED BY SIX SIGMA IMPLEMENTATION

Purpose: To determine the main challenges faced by Six Sigma implementation.

- Based on your Six Sigma implementation experience, could you please indicate *what are the main challenges faced by implementing Six Sigma in your organisation?*

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SECTION 7: CRITICAL SUCCESS FACTORS FOR SUCCESSFUL IMPLEMENTATION OF SIX SIGMA

Purpose: To determine critical success factors for implementing Six Sigma.

- Based on your Six Sigma implementation experience, could you please indicate *what are the most critical factors for successful implementation of Six Sigma programme in your organisation?*

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SECTION 8: ORGANISATION SATISFACTION WITH RESULTS ACHIEVED THROUGH SIX SIGMA IMPLEMENTATION

Purpose: To rate organisation satisfaction with results achieved through Six Sigma implementation.

- Based on your Six Sigma implementation experience, could you please indicate *how you rate your organisation satisfaction with the results achieved through Six Sigma programme?*

  ....
  ....
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****

SECTION 9: COMMENTS

- Any other comments/information which you would like to share regarding Six Sigma programme:

  ....
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  ....

THANK YOU VERY MUCH FOR YOUR TIME, VALUABLE INPUT AND KIND COOPERATION

****

Appendix C: Defect per Million Opportunities (DPMO) Conversion Table

	Defect per Million Opportunities (DPMO)									
Process Sigma	**0.00**	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**
0.0	933 200	931 900	930 600	929 200	927 900	926 500	925 100	923 600	922 200	920 700
0.1	919 200	917 700	916 200	914 700	913 100	911 500	909 900	908 200	906 600	904 900
0.2	903 200	901 500	899 700	898 000	896 200	894 400	892 500	890 700	888 800	886 900
0.3	884 900	883 000	881 000	879 000	877 000	874 900	872 900	870 800	868 600	866 500
0.4	864 300	862 100	859 900	857 700	855 400	853 100	850 800	848 500	846 100	843 800
0.5	841 300	838 900	836 500	834 000	831 500	828 900	826 400	823 800	821 200	818 600
0.6	815 900	813 300	810 600	807 800	805 100	802 300	799 500	796 700	793 900	791 000
0.7	788 100	785 200	782 300	779 400	776 400	773 400	770 400	767 300	764 200	761 100
0.8	758 000	754 900	751 700	748 600	745 400	742 200	738 900	735 700	732 400	729 100
0.9	725 700	722 400	719 000	715 700	712 300	708 800	705 400	701 900	698 500	695 000
1.0	**691 500**	**687 900**	**684 400**	**680 800**	**677 200**	**673 600**	**670 000**	**666 400**	**662 800**	**659 100**
1.1	655 400	651 700	648 000	644 300	640 600	636 800	633 100	629 300	625 500	621 700
1.2	617 900	614 100	610 300	606 400	602 600	598 700	594 800	591 000	587 100	583 200
1.3	579 300	575 300	571 400	567 500	563 600	559 600	555 700	551 700	547 800	543 800
1.4	539 800	535 900	531 900	527 900	523 900	519 900	516 000	512 000	508 000	504 000
1.5	500 000	496 000	492 000	488 000	484 000	480 100	476 100	472 100	468 100	464 100
1.6	460 200	456 200	452 200	448 300	444 300	440 400	436 400	432 500	428 600	424 700
1.7	420 700	416 800	412 900	409 000	405 200	401 300	397 400	393 600	389 700	385 900
1.8	382 100	378 300	374 500	370 700	366 900	363 200	359 400	355 700	352 000	348 300
1.9	344 600	340 900	337 200	333 600	330 000	326 400	322 800	319 200	315 600	312 100
2.0	**308 500**	**305 000**	**301 500**	**298 100**	**294 600**	**291 200**	**287 700**	**284 300**	**281 000**	**277 600**
2.1	274 300	270 900	267 600	264 300	261 100	257 800	254 600	251 400	248 300	245 100
2.2	242 000	238 900	235 800	232 700	229 600	226 600	223 600	220 600	217 700	214 800
2.3	211 900	209 000	206 100	203 300	200 500	197 700	194 900	192 200	189 400	186 700
2.4	184 100	181 400	178 800	176 200	173 600	171 100	168 500	166 000	163 500	161 100
2.5	158 700	156 200	153 900	151 500	149 200	146 900	144 600	142 300	140 100	137 900
2.6	135 700	133 500	131 400	129 200	127 100	125 100	123 000	121 000	119 000	117 000
2.7	115 100	113 100	111 200	109 300	107 500	105 600	103 800	102 000	100 300	98 530
2.8	96 800	95 100	93 420	91 760	90 120	88 510	86 920	85 340	83 790	82 260
2.9	80 760	79 270	77 800	76 360	74 930	73 530	72 150	70 780	69 440	68 110
3.0	**66 810**	**65 520**	**64 260**	**63 010**	**61 780**	**60 570**	**59 380**	**58 210**	**57 050**	**55 920**
3.1	54 800	53 700	52 620	51 550	50 500	49 470	48 460	47 460	46 480	45 510
3.2	44 570	43 630	42 720	41 820	40 930	40 060	39 200	38 360	37 540	36 730
3.3	35 930	35 150	34 380	33 620	32 880	32 160	31 440	30 740	30 050	29 380
3.4	28 720	28 070	27 430	26 800	26 190	25 590	25 000	24 420	23 850	23 300
3.5	22 750	22 220	21 690	21 180	20 680	20 180	19 700	19 230	18 760	18 310
3.6	17 860	17 430	17 000	16 590	16 180	15 780	15 390	15 000	14 630	14 260
3.7	13 900	13 550	13 210	12 870	12 550	12 220	11 910	11 600	11 300	11 010
3.8	10 720	10 440	10 170	9 903	9 642	9 387	9 137	8 894	8 656	8 424
3.9	8 198	7 976	7 760	7 549	7 344	7 143	6 947	6 756	6 569	6 387
4.0	**6 210**	**6 037**	**5 868**	**5 703**	**5 543**	**5 386**	**5 234**	**5 085**	**4 940**	**4 799**
4.1	4 661	4 527	4 397	4 269	4 145	4 025	3 907	3 793	3 681	3 573
4.2	3 467	3 364	3 264	3 167	3 072	2 980	2 890	2 803	2 718	2 635
4.3	2 555	2 477	2 401	2 327	2 256	2 186	2 118	2 052	1 988	1 926
4.4	1 866	1 807	1 750	1 695	1 641	1 589	1 538	1 489	1 441	1 395
4.5	1 350	1 306	1 264	1 223	1 183	1 144	1 107	1 070	1 035	1 001
4.6	968	936	904	874	845	816	789	762	736	711
4.7	687	664	641	619	598	577	557	538	519	501
4.8	483	467	450	434	419	404	390	376	362	350
4.9	337	325	313	302	291	280	270	260	251	242
5.0	**233**	**224**	**216**	**208**	**200**	**193**	**185**	**179**	**172**	**165**
5.1	159	153	147	142	136	131	126	121	117	112
5.2	108	104	100	96	92	88	85	82	78	75
5.3	72	70	67	64	62	59	57	54	52	50
5.4	48	46	44	42	41	39	37	36	34	33
5.5	32	30	29	28	27	26	25	24	23	22
5.6	21	20	19	18	17	17	16	15	15	14
5.7	13	13	12	12	11	11	10	10	9	9
5.8	9	8	8	7	7	7	7	6	6	6
5.9	5	5	5	5	5	4	4	4	4	4
6.0	**3.4**	**3.2**	**3.1**	**3.0**	**2.8**	**2.7**	**2.6**	**2.4**	**2**	**2**

Appendix D: Questionnaires Distributed and Response Rates

No.	Saudi Arabia				Egypt				UAE				**Overall**		
	Organisation Code	No. of Questionnaires Distributed	No. of Valid Questionnaires Returned	% of Response Rate	Organisation Code	No. of Questionnaires Distributed	No. of Valid Questionnaires Returned	% of Response Rate	Organisation Code	No. of Questionnaires Distributed	No. of Valid Questionnaires Returned	% of Response Rate	**No. of Questionnaires Distributed**	**No. of Valid Questionnaires Returned**	**% of Response Rate**
1	S-A	23	10	43.47	E-A	19	9	47.37	U-A	18	8	44.44	**561**	**232**	**41.34**
2	S-B	16	6	37.50	E-B	15	7	46.66	U-B	15	6	40.00			
3	S-C	14	6	42.85	E-C	16	6	37.50	U-C	16	7	43.75			
4	S-D	19	7	36.84	E-D	12	4	33.33	U-D	14	6	42.86			
5	S-E	7	3	42.85	E-E	12	4	33.33	U-E	15	6	40.00			
6	S-F	15	7	46.66	E-F	15	6	40.00	U-F	12	5	41.67			
7	S-G	8	3	37.50	E-G	13	5	38.48	U-G	11	4	36.36			
8	S-H	5	3	60.00	E-H	11	4	36.36	U-H	10	6	60.00			
9	S-I	20	6	30.00	E-I	12	5	41.66	U-I	9	5	55.55			
10	S-J	10	4	40.00	E-J	14	4	28.57	U-J	12	6	50.50			
11	S-K	12	5	41.66	E-K	13	6	46.15	U-K	11	4	36.36			
12	S-L	15	6	40.00	E-L	11	4	36.36	---	---	---	---			
13	S-M	12	7	58.33	E-M	12	3	25.00	---	---	---	---			
14	S-N	10	4	40.00	E-N	13	5	38.46	---	---	---	---			
15	S-O	9	5	55.55	---	---	---	---	---	---	---	---			
16	S-P	9	4	44.44	---	---	---	---	---	---	---	---			
17	S-Q	8	3	37.50	---	---	---	---	---	---	---	---			
18	S-R	10	4	40.00	---	---	---	---	---	---	---	---			
19	S-S	8	4	50.00	---	---	---	---	---	---	---	---			
Total	**19**	**230**	**97**	**42.17**	**14**	**188**	**72**	**38.30**	**11**	**143**	**63**	**44.06**			

Appendix E: Codes for Responding Organisations and Respondents

No.	Saudi Arabia		Egypt		UAE	
	Organisation Code	Respondent Code	Organisation Code	Respondent Code	Organisation Code	Respondent Code
1	S-A	S-A-1	E-A	E-A-1	U-A	U-A-1
2	S-A	S-A-2	E-A	E-A-2	U-A	U-A-2
3	S-A	S-A-3	E-A	E-A-3	U-A	U-A-3
4	S-A	S-A-4	E-A	E-A-4	U-A	U-A-4
5	S-A	S-A-5	E-A	E-A-5	U-A	U-A-5
6	S-A	S-A-6	E-A	E-A-6	U-A	U-A-6
7	S-A	S-A-7	E-A	E-A-7	U-A	U-A-7
8	S-A	S-A-8	E-A	E-A-8	U-A	U-A-8
9	S-A	S-A-9	E-A	E-A-9	U-B	U-B-1
10	S-A	S-A-10	E-B	E-B-1	U-B	U-B-2
11	S-B	S-B-1	E-B	E-B-2	U-B	U-B-3
12	S-B	S-B-2	E-B	E-B-3	U-B	U-B-4
13	S-B	S-B-3	E-B	E-B-4	U-B	U-B-5
14	S-B	S-B-4	E-B	E-B-5	U-B	U-B-6
15	S-B	S-B-5	E-B	E-B-6	U-C	U-C-1
16	S-B	S-B-6	E-B	E-B-7	U-C	U-C-2
17	S-C	S-C-1	E-C	E-C-1	U-C	U-C-3
18	S-C	S-C-2	E-C	E-C-2	U-C	U-C-4
19	S-C	S-C-3	E-C	E-C-3	U-C	U-C-5
20	S-C	S-C-4	E-C	E-C-4	U-C	U-C-6
21	S-C	S-C-5	E-C	E-C-5	U-C	U-C-7
22	S-C	S-A-6	E-C	E-C-6	U-D	U-D-1
23	S-D	S-D-1	E-D	E-D-1	U-D	U-D-2
24	S-D	S-D-2	E-D	E-D-2	U-D	U-D-3
25	S-D	S-D-3	E-D	E-D-3	U-D	U-D-4
26	S-D	S-D-4	E-D	E-D-4	U-D	U-D-5
27	S-D	S-D-5	E-E	E-E-1	U-D	U-D-6
28	S-D	S-D-6	E-E	E-E-2	U-E	U-E-1
29	S-D	S-D-7	E-E	E-E-3	U-E	U-E-2
30	S-E	S-E-1	E-E	E-E-4	U-E	U-E-3
31	S-E	S-E-2	E-F	E-F-1	U-E	U-E-4
32	S-E	S-E-3	E-F	E-F-2	U-E	U-E-5
33	S-F	S-F-1	E-F	E-F-3	U-E	U-E-6
34	S-F	S-F-2	E-F	E-F-4	U-F	U-F-1
35	S-F	S-F-3	E-F	E-F-5	U-F	U-F-2
36	S-F	S-F-4	E-F	E-F-6	U-F	U-F-3
37	S-F	S-F-5	E-G	E-G-1	U-F	U-F-4
38	S-F	S-F-6	E-G	E-G-2	U-F	U-F-5
39	S-F	S-F-7	E-G	E-G-3	U-G	U-G-1
40	S-G	S-G-1	E-G	E-G-4	U-G	U-G-2
41	S-G	S-G-2	E-G	E-G-5	U-G	U-G-3
42	S-G	S-G-3	E-H	E-H-1	U-G	U-G-4
43	S-H	S-H-1	E-H	E-H-2	U-H	U-H-1
44	S-H	S-H-2	E-H	E-H-3	U-H	U-H-2
45	S-H	S-H-3	E-H	E-H-4	U-H	U-H-3
46	S-I	S-I-1	E-I	E-I-1	U-H	U-H-4
47	S-I	S-I-2	E-I	E-I-2	U-H	U-H-5
48	S-I	S-I-3	E-I	E-I-3	U-H	U-H-6
49	S-I	S-I-4	E-I	E-I-4	U-I	U-I-1
50	S-I	S-I-5	E-I	E-I-5	U-I	U-I-2
51	S-I	S-I-6	E-J	E-J-1	U-I	U-I-3
52	S-J	S-J-1	E-J	E-J-2	U-I	U-I-4
53	S-J	S-J-2	E-J	E-J-3	U-I	U-I-5
54	S-J	S-J-3	E-J	E-J-4	U-J	U-J-1
55	S-J	S-J-4	E-K	E-K-1	U-J	U-J-2

(Continued)

Appendix E: (continued)

No.	Saudi Arabia		Egypt		UAE	
	Organisation Code	Respondent Code	Organisation Code	Respondent Code	Organisation Code	Respondent Code
56	S-K	S-K-1	E-K	E-K-2	U-J	U-J-3
57	S-K	S-K-2	E-K	E-K-3	U-J	U-J-4
58	S-K	S-K-3	E-K	E-K-4	U-J	U-J-5
59	S-K	S-K-4	E-K	E-K-5	U-J	U-J-6
60	S-K	S-K-5	E-K	E-K-6	U-K	U-K-1
61	S-L	S-L-1	E-L	E-L-1	U-K	U-K-2
62	S-L	S-L-2	E-L	E-L-2	U-K	U-K-3
63	S-L	S-L-3	E-L	E-L-3	U-K	U-K-4
64	S-L	S-L-4	E-L	E-L-4	---	---
65	S-L	S-L-5	E-M	E-M-1	---	---
66	S-L	S-L-6	E-M	E-M-2	---	---
67	S-M	S-M-1	E-M	E-M-3	---	---
68	S-M	S-M-2	E-N	E-N-1	---	---
69	S-M	S-M-3	E-N	E-N-2	---	---
70	S-M	S-M-4	E-N	E-N-3	---	---
71	S-M	S-M-5	E-N	E-N-4	---	---
72	S-M	S-M-6	E-N	E-N-5	---	---
73	S-M	S-M-7	---	---	---	---
74	S-N	S-N-1	---	---	---	---
75	S-N	S-N-2	---	---	---	---
76	S-N	S-N-3	---	---	---	---
77	S-N	S-N-4	---	---	---	---
78	S-O	S-O-1	---	---	---	---
79	S-O	S-O-2	---	---	---	---
70	S-O	S-O-3	---	---	---	---
81	S-O	S-O-4	---	---	---	---
82	S-O	S-O-5	---	---	---	---
83	S-P	S-P-1	---	---	---	---
84	S-P	S-P-2	---	---	---	---
85	S-P	S-P-3	---	---	---	---
86	S-P	S-P-4	---	---	---	---
87	S-Q	S-Q-1	---	---	---	---
88	S-Q	S-Q-2	---	---	---	---
89	S-Q	S-Q-3	---	---	---	---
90	S-R	S-R-1	---	---	---	---
91	S-R	S-R-2	---	---	---	---
92	S-R	S-R-3	---	---	---	---
93	S-R	S-R-4	---	---	---	---
94	S-S	S-S-1	---	---	---	---
95	S-S	S-S-2	---	---	---	---
96	S-S	S-S-3	---	---	---	---
97	S-S	S-S-4	---	---	---	---
Total	**19**	**97**	**14**	**72**	**11**	**63**

Appendix F: Codes for Interviewees, Organisations and Positions

No.	Saudi Arabia			Egypt			UAE		
	Organisation Code	Interviewee Code	Interviewee Position	Organisation Code	Interviewee Code	Interviewee Position	Organisation Code	Interviewee Code	Interviewee Position
1	S-A	S-A-1	Quality Manager	E-A	E-A-1	CEO	U-A	U-A-1	General Manager
2	S-A	S-A-2	Champion	E-A	E-A-2	Black Belt	U-A	U-A-2	Champion
3	S-A	S-A-3	Black Belt	E-B	E-B-1	Quality Manager	U-A	U-A-3	Black Belt
4	S-A	S-A-4	Green Belt	E-B	E-B-2	Black Belt	U-B	U-B-1	CEO
5	S-B	S-B-1	CEO	E-B	E-B-3	Green Belt	U-C	U-C-1	Black Belt
6	S-B	S-B-2	Black Belt	E-C	E-C-1	Black Belt	U-C	U-C-2	Black Belt
7	S-C	S-C-1	Champion	E-D	E-D-1	Champion	U-D	U-D-1	Master Black Belt
8	S-C	S-C-2	Green Belt	E-D	E-D-2	Black Belt	U-E	U-E-1	Black Belt
9	S-D	S-E-1	Senior Manager	E-D	E-D-3	Green Belt	U-F	U-F-1	CEO
10	S-E	S-E-1	Black Belt	E-E	E-E-1	Black Belt	U-F	U-F-2	Quality Manager
11	S-G	S-G-1	Black Belt	E-F	E-F-1	General Manager	U-G	U-G-1	General Manager
12	S-G	S-G-2	Green Belt	E-F	E-F-2	Master Black Belt	U-H	U-H-1	Black Belt
13	S-H	S-H-1	Master Black Belt	E-G	E-G-1	Green Belt	U-I	U-I-1	Champion
14	S-I	S-I-1	Green Belt	E-H	E-H-1	Black Belt	U-I	U-I-2	Master Black Belt
15	S-J	S-J-1	Black Belt	E-H	E-H-2	Green Belt	U-J	U-J-1	Champion
16	S-K	S-K-1	Black Belt	E-I	E-I-1	Quality Manager	U-J	U-J-2	Green Belt
17	S-K	S-K-2	Green Belt	E-I	E-I-2	Green Belt	U-K	U-K-1	Master Black Belt
18	S-L	S-L-1	Senior Manager	E-J	E-J-1	General Manager	U-K	U-K-2	Green Belt
19	S-L	S-L-2	Master Black Belt	E-J	E-J-2	Green Belt	U-I	U-I-2	Master Black Belt
20	S-M	S-M-1	CEO	E-K	E-K-1	Quality Manager	U-J	U-J-1	Champion
21	S-N	S-N-1	General Manager	E-K	E-K-2	Senior Manager	U-J	U-J-2	Black Belt
22	S-O	S-O-1	Black Belt	E-L	E-L-1	Green Belt	U-K	U-K-1	Master Black Belt
23	S-P	S-P-1	Black Belt	E-M	E-M-1	Black Belt	U-K	U-K-2	Quality Manager
24	S-R	S-R-1	Champion	E-N	E-N-1	General Manager	---	---	---
25	S-S	S-S-1	Master Black Belt	E-N	E-N-2	Champion	---	---	---
26	---	---	---	E-N	E-N-3	Black Belt	---	---	---
Total	**25 (33.78%)**			**26 (35.14%)**			**23 (31.08%)**		

Appendix G: Tables Related to Quantitative Data Analysis and Statistical Tests Results (Chapter 6)

Table G1: Sectors of responding organisations

Sector	No.	Saudi Arabia		Egypt		UAE		Overall	
		Organisation Code	Sector %	Organisation Code	Sector %	Organisation Code	Sector %	No. of Org.	Sector %
Manufacturing	1	S-A	47.37	E-A	57.14	U-B	27.27	20	45.45
	2	S-B		E-C		U-C			
	3	S-D		E-D		U-H			
	4	S-F		E-E		---			
	5	S-G		E-H		---			
	6	S-H		E-I		---			
	7	S-L		E-M		---			
	8	S-M		E-N		---			
	9	S-O		---		---			
Services	1	S-C	52.63	E-B	42.86	U-A	72.73	24	54.55
	2	S-E		E-F		U-D			
	3	S-I		E-G		U-E			
	4	S-J		E-J		U-F			
	5	S-K		E-K		U-G			
	6	S-N		E-L		U-I			
	7	S-P		---		U-J			
	8	S-Q		---		U-K			
	9	S-R		---		---			
	10	S-S		---		---			
Total		19		14		11		44	

Table G2: Size of responding organisations by number of employees

Size	No.	Saudi Arabia			Egypt			UAE			Overall	
		Org. Code	No. of Employees	Size %	Org. Code	No. of Employees	Size %	Org. Code	No. of Employees	Size %	No. of Org.	Size %
SME (≤ 250)	1	---	---	0	E-H	51-150	14.29	A-E	151-250	9.10	3	6.82
	2	---	---		E-L	151-250		---	---			
Large organisation (> 250)	1	S-A	> 10000	100	E-A	5001-10000	85.71	U-A	2501-5000	90.90	41	93.18
	2	S-B	> 10000		E-B	5001-10000		U-B	501-1000			
	3	S-C	5001-10000		E-C	5001-10000		U-C	2501-5000			
	4	S-D	> 10000		E-D	1001-2500		U-D	501-1000			
	5	S-E	5001-10000		E-E	2501-5000		U-F	1001-2500			
	6	S-F	1001-2500		E-F	501-1000		U-G	501-1000			
	7	S-G	2501-5000		E-G	2501-5000		U-H	251-500			
	8	S-H	2501-5000		E-I	501-1000		U-I	251-500			
	9	S-I	5001-10000		E-J	501-1000		U-J	501-1000			
	10	S-J	2501-5000		E-K	251-500		U-K	251-500			
	11	S-K	1001-2500		E-M	501-1000		---	---			
	12	S-L	2501-5000		E-N	251-500		---	---			
	13	S-M	1001-2500		---	---		---	---			
	14	S-N	2501-5000		---	---		---	---			
	15	S-O	501-1000		---	---		---	---			
	16	S-P	5001-10000		---	---		---	---			
	17	S-Q	2501-5000		---	---		---	---			
	18	S-R	251-500		---	---		---	---			
	19	S-S	501-1000		---	---		---	---			
Total		19			14			11			44	

Table G3: Results of Kruskal-Wallis test of means between three Middle East countries (Saudi Arabia, Egypt and UAE)

Key issues of Six Sigma implementation	Kruskal-Wallis Test						
	Mean Rank			Differences (N=232)			
	Saudi Arabia (N=97)	Egypt (N=72)	UAE (N=63)	Chi-squared	*P*	Sig. (2-tailed)	Difference
Reasons/Benefits (mean)	114.53	112.84	123.71	1.136	.567	$P > 0.05$	NO
Challenges (mean)	110.13	114.11	129.04	3.448	.178	$P > 0.05$	NO
CSFs (mean)	124.58	109.93	111.57	2.584	.275	$P > 0.05$	NO

Table G4: Results of Mann-Whitney test of means between two sectors (manufacturing and services)

Key issues of Six Sigma implementation	Mann-Whitney Test					
	Mean Rank		Differences (N=232)			
	Manufacturing (N=113)	Services (N=119)	Z	*P*	Sig. (2-tailed)	Difference
Reasons/Benefits (mean)	108.90	123.71	-1.768	.077	$P > 0.05$	NO
Challenges (mean)	107.81	124.75	-2.005	.045	$P < 0.05$	YES
CSFs (mean)	122.59	110.72	-1.387	.165	$P > 0.05$	NO

Table G5: Results of Mann-Whitney test of means between two sizes (large organisation and SME)

Key issues of Six Sigma implementation	Mann-Whitney Test					
	Mean Rank		Differences (N=232)			
	Large organisation (N=218)	SME (N=14)	Z	*P*	Sig. (2-tailed)	Difference
Reasons/Benefits (mean)	116.28	119.89	-.205	.837	$P > 0.05$	NO
Challenges (mean)	115.78	127.68	-.671	.502	$P > 0.05$	NO
CSFs (mean)	116.73	112.89	-.214	.831	$P > 0.05$	NO

Table G6: Results of Mann-Whitney test of means between two organisational positions (managerial and operational)

Key issues of Six Sigma implementation	Mann-Whitney Test					
	Mean Rank		Differences (N=232)			
	Managerial (N=149)	Operational (N=83)	Z	*P*	Sig. (2-tailed)	Difference
Reasons/Benefits (mean)	116.67	116.19	-.055	.956	$P > 0.05$	NO
Challenges (mean)	117.00	115.60	-.159	.874	$P > 0.05$	NO
CSFs (mean)	115.18	118.87	-.413	.680	$P > 0.05$	NO

Table G7: Correlation between CSFs and satisfaction (Spearman's rho)

No.	CSFs	Satisfaction	
F1	Top management commitment and support	Correlation Coefficient	.715**
		Sig. (2-tailed).	0.000
F2	Readiness for cultural change	Correlation Coefficient	.634**
		Sig. (2-tailed).	0.000
F3	Continuous training and education	Correlation Coefficient	.524**
		Sig. (2-tailed).	0.000
F4	Teamwork	Correlation Coefficient	.421**
		Sig. (2-tailed).	0.000
F5	Effective communication	Correlation Coefficient	.386**
		Sig. (2-tailed).	0.000
F6	Formation of Six Sigma organisational structure	Correlation Coefficient	.401**
		Sig. (2-tailed).	0.000
F7	Integrating Six Sigma with customer satisfaction	Correlation Coefficient	.364**
		Sig. (2-tailed).	0.000
F8	Integrating Six Sigma with corporate business strategy	Correlation Coefficient	.421**
		Sig. (2-tailed).	0.000
F9	Integrating Six Sigma with rewards and recognition system	Correlation Coefficient	.399**
		Sig. (2-tailed).	0.000
F10	Integrating Six Sigma with employees	Correlation Coefficient	.422**
		Sig. (2-tailed).	0.000
F11	Integrating Six Sigma with suppliers	Correlation Coefficient	.355**
		Sig. (2-tailed).	0.000
F12	Integrating Six Sigma with financial goals	Correlation Coefficient	.308**
		Sig. (2-tailed).	0.000
F13	Integrating Six Sigma with existing initiatives	Correlation Coefficient	.327**
		Sig. (2-tailed).	0.000
F14	Use of Six Sigma methodologies and tools	Correlation Coefficient	.311**
		Sig. (2-tailed).	0.000
F15	Project management skills	Correlation Coefficient	.321**
		Sig. (2-tailed).	0.000
F16	Project prioritisation, selection, evaluation, tracking and reviews	Correlation Coefficient	.436**
		Sig. (2-tailed).	0.000
F17	Integrating Six Sigma with (IT) infrastructure	Correlation Coefficient	.467**
		Sig. (2-tailed).	0.000
F18	Competitive benchmarking for Six Sigma	Correlation Coefficient	.465**
		Sig. (2-tailed).	0.000
F19	Use of external consultants	Correlation Coefficient	.428**
		Sig. (2-tailed).	0.000

Table G8: Correlations between CSFs and satisfaction (Spearman's rho)

No.	CSFs		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	Satisfaction
F1	Top management commitment and support	Correlation Coefficient	1.000	.617**	.554**	.375**	.337**	.431**	.312**	.432**	.444**	.402**	.391**	.357**	.354**	.329**	.474**	.406**	.454**	.507**	.524**	.715**
		Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F2	Readiness for cultural change	Correlation Coefficient	.617**	1.000	.438**	.510**	.336**	.347**	.273**	.441**	.371**	.372**	.389**	.307**	.322**	.284**	.404**	.331**	.517**	.323**	.416**	.634**
		Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F3	Continuous training and education	Correlation Coefficient	.554**	.438**	1.000	.411**	.446**	.623**	.294**	.566**	.310**	.479**	.413**	.414**	.369**	.363**	.367**	.400**	.406**	.451**	.455**	.524**
		Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F4	Teamwork	Correlation Coefficient	.375**	.510**	.411**	1.000	.248**	.438**	.316**	.511**	.279**	.449**	.339**	.215**	.291**	.297**	.293**	.263**	.340**	.371**	.322**	.421**
		Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F5	Effective communication	Correlation Coefficient	.337**	.336**	.446**	.248**	1.000	.298**	.386**	.444**	.426**	.460**	.468**	.328**	.315**	.273**	.328**	.380**	.371**	.401**	.363**	.386**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F6	Formation of Six Sigma organisational structure	Correlation Coefficient	.431**	.347**	.623**	.438**	.298**	1.000	.224**	.557**	.361**	.348**	.330**	.291**	.299**	.287**	.394**	.252**	.318**	.380**	.313**	.401**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F7	Integrating Six Sigma with customer satisfaction	Correlation Coefficient	.312**	.273**	.294**	.316**	.386**	.224**	1.000	.301**	.390**	.346**	.336**	.264**	.227**	.184**	.264**	.352**	.332**	.260**	.308**	.364**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.001		0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000
F8	Integrating Six Sigma with corporate business strategy	Correlation Coefficient	.432**	.441**	.566**	.511**	.444**	.557**	.301**	1.000	.370**	.498**	.505**	.380**	.464**	.343**	.455**	.444**	.458**	.445**	.462**	.421**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F9	Integrating Six Sigma with rewards and recognition system	Correlation Coefficient	.444**	.371**	.310**	.279**	.426**	.361**	.390**	.370**	1.000	.273**	.524**	.229**	.319**	.208**	.366**	.276**	.328**	.290**	.398**	.399**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
F10	Integrating Six Sigma with employees	Correlation Coefficient	.402**	.372**	.479**	.449**	.460**	.348**	.346**	.498**	.273**	1.000	.403**	.426**	.445**	.321**	.436**	.449**	.392**	.400**	.388**	.422**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

** Correlation significant at 0.01 level (2-tailed)

(continued)

Table: (continued)

No.	CSFs		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	Satisfaction
F11	Integrating Six Sigma with Suppliers	Correlation Coefficient	.391**	.389**	.413**	.339**	.468**	.330**	.336**	.505**	.524**	.403**	1.000	.319**	.516**	.322**	.507**	.409**	.451**	.374**	.463**	.355**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F12	Integrating Six Sigma with Financial Goals	Correlation Coefficient	.357**	.307**	.414**	.215**	.328**	.291**	.462**	.380**	.229**	.426**	.319**	1.000	.379**	.344**	.383**	.450**	.225**	.425**	.180**	.308**
		Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.001	0.000	0.006	0.000
F13	Integrating Six Sigma with Existing Initiatives	Correlation Coefficient	.354**	.322**	.369**	.291**	.315**	.299**	.227**	.464**	.319**	.445**	.516**	.379**	1.000	.252**	.418**	.479**	.444**	.427**	.543**	.327**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
F14	Use of Six Sigma Methodologies and Tools	Correlation Coefficient	.329**	.284**	.363**	.297**	.273**	.287**	.184**	.343**	.208**	.321**	.322**	.344**	.252**	1.000	.265**	.404**	.399**	.370**	.374**	.311**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.001	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
F15	Project Management Skills	Correlation Coefficient	.474**	.404**	.367**	.293**	.328**	.394**	.264**	.455**	.366**	.436**	.507**	.383**	.418**	.265**	1.000	.381**	.505**	.516**	.503**	.321**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
F16	Project Prioritisation, Selection and Reviews	Correlation Coefficient	.406**	.331**	.400**	.263**	.380**	.252**	.352**	.444**	.276**	.449**	.409**	.450**	.479**	.404**	.381**	1.000	.420**	.501**	.460**	.436**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
F17	Integrating Six Sigma with (IT) Infrastructure	Correlation Coefficient	.454**	.517**	.406**	.340**	.371**	.318**	.332**	.458**	.328**	.392**	.451**	.225**	.444**	.399**	.505**	.420**	1.000	.460**	.580**	.467**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000		0.000	0.000	0.000
F18	Competitive Benchmarking for Six Sigma	Correlation Coefficient	.507**	.323**	.451**	.371**	.401**	.380**	.260**	.445**	.290**	.400**	.374**	.425**	.427**	.370**	.516**	.501**	.460**	1.000	.478**	.465**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
F19	Use of External Consultants	Correlation Coefficient	.524**	.416**	.455**	.322**	.363**	.313**	.308**	.462**	.398**	.388**	.463**	.180**	.543**	.374**	.503**	.460**	.580**	.478**	1.000	.428**
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.000		0.000
S	**Satisfaction**	Correlation Coefficient	.715**	.634**	.524**	.421**	.386**	.401**	.364**	.421**	.399**	.422**	.355**	.308**	.327**	.311**	.321**	.436**	.467**	.465**	.428**	1.000
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

** Correlation significant at 0.01 level (2-tailed)

Appendix H: Tables Related to Qualitative Data Analysis and Statistical Tests Results (Chapter 7)

Table H1: Sectors of interviewees' organisations

Sector	No.	Saudi Arabia		Egypt		UAE		Overall	
		Organisation Code	Sector %	Organisation Code	Sector %	Organisation Code	Sector %	**No. of Org.**	**Sector %**
Manufacturing	1	S-A		E-A		U-B			
	2	S-B		E-C		U-C			
	3	S-D		E-D		U-H			
	4	S-F	46.66	E-E	63.64	---	27.27	**17**	**45.95**
	5	S-G		E-H		---			
	6	S-H		E-I		---			
	7	S-L		E-M		---			
Services	1	S-C		E-B		U-A			
	2	S-E		E-F		U-D			
	3	S-I		E-G		U-E			
	4	S-J	53.33	E-J	36.36	U-F	72.73	**20**	**54.05**
	5	S-K		---		U-G			
	6	S-N		---		U-I			
	7	S-P		---		U-J			
	8	S-Q		---		U-K			
Total		**15**		**11**		**11**		**37**	

Table H2: Size of interviewees' organisations by number of employees

Size	No.	Saudi Arabia			Egypt			UAE			Overall	
		Org. Code	No. of Employees	Size %	Org. Code	No. of Employees	Size %	Org. Code	No. of Employees	Size %	**No. of Org.**	**Size %**
SME (≤ 250)	1	---	---	0	E-H	51-150	9.09	U-E	151-250	9.09	**2**	**5.41**
Large organisation (> 250)	1	S-A	>10000		E-A	5001-10000		U-A	2501-5000			
	2	S-B	> 10000		E-B	5001-10000		U-B	501-1000			
	3	S-C	5001-10000		E-C	5001-10000		U-C	2501-5000			
	4	S-D	> 10000		E-D	1001-2500		U-D	501-1000			
	5	S-E	5001-10000		E-E	2501-5000		U-F	1001-2500			
	6	S-F	1001-2500		E-F	501-1000		U-G	501-1000			
	7	S-G	2501-5000		E-G	2501-5000		U-H	251-500			
	8	S-H	2501-5000	100	E-I	501-1000	90.91	U-I	251-500	90.91	**35**	**94.59**
	9	S-I	5001-10000		E-J	501-1000		U-J	501-1000			
	10	S-J	2501-5000		E-M	251-500		U-K	251-500			
	11	S-K	1001-2500		---	---		---	---			
	12	S-L	2501-5000		---	---		---	---			
	13	S-N	1001-2500		---	---		---	---			
	14	S-O	2501-5000		---	---		---	---			
	15	S-R	501-1000		---	---		---	---			
Total		**15**			**11**			**11**			**37**	

Word count: 131,292